

Economics Education and Research Consortium

Working Paper Series

ISSN 1561-2422



No 06/08

Effects of the 2004 Personal Income Tax System Reform on the Shadow Sector in Ukraine

Andrii Oliinyk

Larysa Koziarivska

This project (No. 05-054) was supported
by the Economics Education and Research Consortium

All opinions expressed here are those of the authors
and not those of the Economics Education and Research Consortium

Research dissemination by the EERC may include views on policy,
but the EERC itself takes no institutional policy positions

Research area: **Public Economics**

JEL Classification: D21, E64, H21, H25, H26, H32

OLIINYK A.S., KOZIARIVSKA L.V. Effects of the 2004 Personal Income Tax System Reform on the Shadow Sector in Ukraine. — Moscow: EERC, 2006.

The paper researches into the consequences of the pit reform of 2004 introduced on tax revenues, shadow activities, and income streams. The research approach adopted involves constructing theoretical general equilibrium model adapted to Ukrainian practices and further empirical testing of the hypotheses on the firm-level data. The study leads to inferring that the reform did not stimulate any tangible structural changes in the economy; with no effect on the shadow sector size. As a result of the reform, the government's income in the form of PIT revenues was redistributed to firms. The research shows that under the present conditions no other rate is expected to perform better the existing rate. Within the framework of existing structural ties in the economy it would be beneficial to increase compliance by introducing a more severe punishment for evasion.

Keywords. Ukraine, tax reform, tax policy, tax evasion, shadow economy, behavioural response.

Acknowledgements. Authors would like to express their gratitude to those are grateful to Dr. Roy Gardner from Indiana University for useful comments and help along the work of the research; Roman Sysuyev from University of Princeton for invaluable advice in developing and polishing the general equilibrium model. The Authors are also thankful to Dr. Serguei Maliar from University of Alicante for the initial guidance of the research and the organization of EERC for providing financial support enabling the study.

Andrii Oliinyk

Embassy of Finland in Ukraine

Research Associate

Kosmonavtiv st. 6, s. Hatne, Kyiv-Sviatoshyn reg., 08160 Kyiv obl., Ukraine

Tel.: +38044 484 66 13

Fax: +38044 484 66 15

E-mail: aoliinyk@eerc.kiev.ua

Larysa Koziarivska

EERC Ukraine

Research Associate

Verbitskoho st. 34, apt. 275, 02121 Kyiv, Ukraine

Tel.: +38044 560 17 50

E-mail: lkoziarivska@eerc.kiev.ua

CONTENTS

NON-TECHNICAL SUMMARY	4
1. INTRODUCTION	6
1.1. Hypotheses	8
1.2. Research strategy	9
2. REVIEW OF CONCEPTUAL FRAMEWORK	9
3. DATA SPECIFICATION	13
4. SHORT-RUN MODEL	13
4.1. Developing the model	13
4.2. Testing hypotheses	19
5. LONG-RUN MODEL	22
5.1. Specifying the model	22
5.2. Solving the model analytically	24
5.3. Calibrating the model	26
5.4. Evaluation	27
6. ECONOMETRIC SPECIFICATION AND ESTIMATION	30
6.1. Testing the first hypothesis	30
6.2. Testing the second hypothesis	33
6.3. Testing the third hypothesis	35
7. CONCLUSIONS AND RECOMMENDATIONS	36
APPENDICES	39
A1. The history of tax reform in Ukraine	39
A2. Data sampling	40
A3. Creating data series	42
A4. Data description and analysis	48
A5. Programming short run model	51
A6. Programming long run model	53
A7. Testing hypothesis 1	55
A8. Testing hypothesis 2	59
A9. Testing hypothesis 3	61
REFERENCES	64

NON-TECHNICAL SUMMARY

In Ukraine, the question of reforming the PIT system has been long in the focus of an intense discussion. The Ukrainian tax system inheriting many problems, typical for all post-Soviet countries, created a lot of incentives and opportunities for substantial tax evasion, and, therefore, was bound to fail as a meaningful tax policy instrument.

The PIT system has been reformed several times during the period of independence, but most of changes were introduced in 2003: tax base broadened, the tax rate structure simplified, and tax burden reduced — the progressive tax rate of 0–40% was replaced with a flat 13% rate. The major purpose, the reform is called to serve, is de-shadowing personal income resulting in increased PIT revenues as well as improving tax administration. The main assumption behind the reform design is that the low and non-progressive tax rate would encourage individuals to report a bigger share of their income. Thus, de-shadowing and broadening of the tax base were expected to compensate for the significant cut in the tax rate. These considerations were based on the successful experience of other transition countries, in particular Russia.

However, despite quite significant increase in real personal income, PIT revenues experienced a considerable slump in Ukraine in 2004 with a slight improvement in 2005. Thus, even if there is some de-shadowing effect due to the tax reform, tax base broadening did not compensate for the cut in the tax rate. Now it is obvious that a cut-and-paste policymaking model has its serious drawbacks.

The unsuccessful policy experiment called for a detailed empirical research at micro data level. In the framework of the research, a methodology was developed, relevant to personal-income tax response analysis in the Ukrainian context. The research approach adopted involves constructing theoretical general equilibrium model adapted to practices in the Ukrainian economy. Empirical testing of the hypotheses on the firm-level data that follows revealed the reform effects and confirmed adequacy of the theoretical model and validity of the assumptions adapted.

Both analytical solution of the theoretical model and econometrician testing do not reveal any significant de-shadowing effect of the PIT reform. This means that the reform did not stimulate any tangible structural changes in the economy. However, according to empirical investigations, private firms and firms with labour-intensive technology, such as services and trading, demonstrated a bit higher increase in official wages in a response to the change in the PIT rate than others.

Also, we conclude that a decreased effective PIT rate provoked a considerable fall in PIT payments. In particular, this effect is larger for firms, which have no evidence for de-shadowing. However, big firms, in comparison with small firms, have a more pronouncing de-shadowing effect and simultaneously a larger fall in PIT payments. It appears that lower marginal PIT rate can be more significant for big firms, that traditionally hire high-skilled labour with relatively higher level of salary. At the same time, the effective PIT rate became much lower for them after the reform, so their PIT payments decreased at the more extent than small firms' payments.

Therefore, the government's income in a form of PIT revenues was redistributed to firms after the reform, which allowed firms to pay higher net wages to their employees. Those firms, which have more considerable reduction in their PIT payments, increased a net wage rate to the more extent.

The weak effect of the reform is predetermined by conditions of the dominating labour demand channel, formalizes in the analytical model, when employers' decisions are strictly bounded by their costs structure, and employees' influence in negotiating labour contracts is minimized. In such conditions, the PIT system reform should be accompanied with structural reforms in the social security system, the pension system, and labour market regulations.

The results we obtained from the analytical model enable us to make the conclusion that within the framework of existing structural ties in the economy it is possible to increase compliance by introducing a more severe punishment for evasion. This is expected to be beneficial both for budget revenues and general economic development of the country. The existing tax rate is close to optimal and under the present conditions no other rate is expected to bring significantly better results.

Under the results of the study the expected punishment and the low perceived probability of being caught evading are too low, which stipulates for the low observed tax compliance. The findings of the model show that audit efforts must be intensified by about 3-fold with tax rate kept unchanged. Further improvements to the system, besides intensification of audit efforts, should be the subject of further research.

1. INTRODUCTION

The personal income tax is traditionally a major source of the budget revenue accounting for almost 25% of all tax revenues (Table 1). PIT revenues demonstrated stable up-ward growth at accelerating pace since 1993. But, at the same time, more than 90% of PIT revenues came from employees' wages, and about 95% of PIT revenues came from taxpayers with less than UAH 400 monthly income.¹ These facts indicated serious problems of PIT system, more disturbing of which are large shadow sector and poor income redistribution in the society.

Table 1. Personal income tax revenues

	2001	2002	2003	2004
PIT revenues	8774.9	10823.9	13521.3	13213.3
Rate of change, % to previous period	+37.6	+23.3	+24.9	−2.3
Share of all tax revenues, %	23.9	23.8	24.9	20.9
Share of GDP, %	4.3	4.8	5.1	3.8

Source: *Finance of Ukraine* No. 10, p. 38 (2005).

Before 2004, the PIT system of Ukraine was characterized by a progressive structure of tax rates, different tax burden on income from different sources, and numerous exemptions and privileges, which narrowed the tax base. Thus, income from primary employment was taxed at 10–40% rate, while income from the secondary employment — at 20% rate, and royalties — at 20–60% rate.² This rather high tax burden combined with weak tax administration is believed to contributed to massive tax evasion.³ Since 1991, the PIT system was reformed several times (app.2) but no problem solving changes were introduced.

The 2003 PIT reform stipulated for (i) abolishing many exemptions and privileged group of taxpayers and (ii) instituting the flat tax rate of 13%. The process of tax reforming is followed by a lot of dispute. Official expert estimates pointed losses for the consolidated budget from introduction of the new tax system in the amount of UAH 4 to 5 billion. But the changes introduced were supposed to bring some part on the huge unofficial sector out of the shadow. Policy-makers believed that this decrease in the tax burden encouraged taxpayers to declare more income, in particular, high income.

¹ IER Advisory paper.

² IER Advisory paper.

³ According to the (2003) joint research "Trends of the Shadow Economy in Ukraine" (on the report, see Калугин, 2003) by the Ministry of Economy and European Integration of Ukraine and the World Bank the size of the shadow sector in Ukraine was 41.08% of the official GDP (down from 65.77% in 1997).

Indeed, the tax rate of 13% considerably reduced total labour expenses if a wage rate is comparatively high, as we can see at Fig. 1.

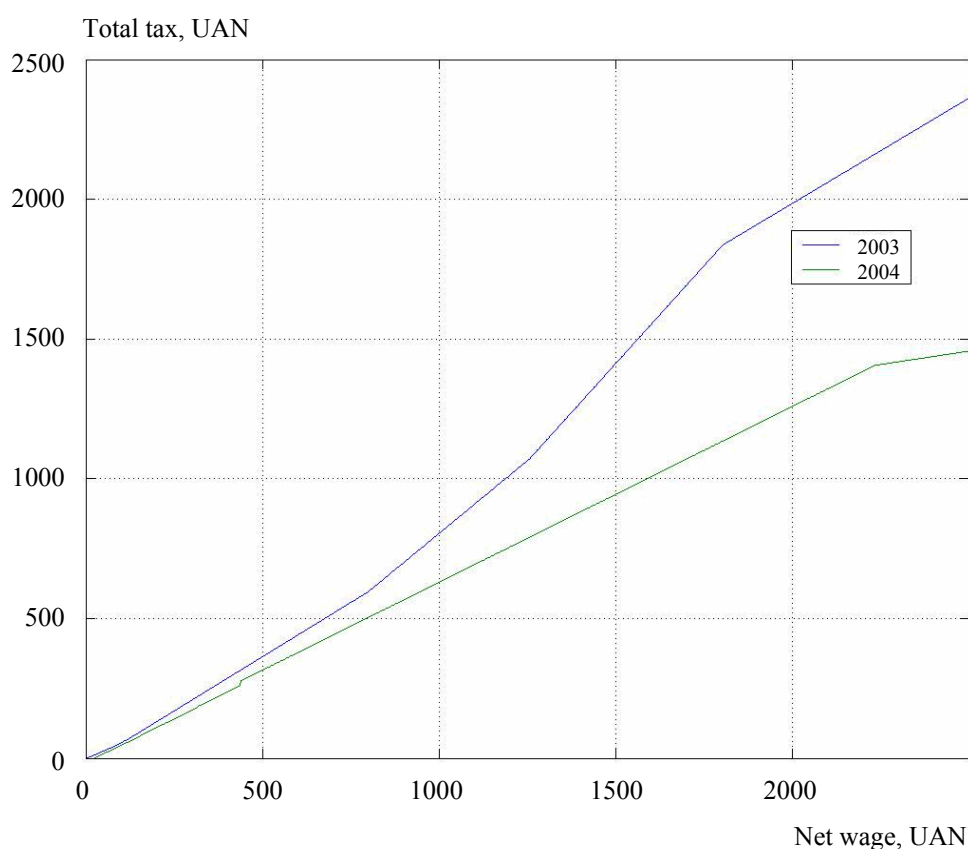


Fig. 1. Comparison of 2003 and 2004 taxation burden paid over net wage⁴

In so, the government expected quite significant personal income de-shadowing as a result of the reform, which might compensate for the PIT revenues fall due to the tax rate cut. Apart from that, the broader PIT base was supposed to contribute to PIT revenues as well. Unfortunately, presumptions of the reform appeared to be not true. The PIT revenues fell for the first time since 1993 (Fig. 1), and the share of PIT revenues in all taxes also fell (Table 1). Moreover, the broadened definition of the PIT base did not contribute much to the PIT revenues. The PIT revenues from additional income sources, introduced for taxation, were not significant, and wages remained the major source of the PIT revenues (Fig. 2).

Now, it is becoming obvious that just reducing tax burden, even so significant, is not a panacea for PIT evasion and may lead to financial instability in the short-run. To develop a more meaningful PIT policy, the nature of PIT evasion should be studied more carefully.

The objectives of the study are the following:

1. Researching into the consequences of the tax cut introduced: how it affected the behaviour of economic agents and the size of the shadow sector of the economy. The focus of the study is

⁴ Source: Own calculations.

revealing peculiarities of or tax evasion behaviour in terms of Ukraine, so researching into the ties and factors, determining the scale of the shadow sector in Ukraine, and revealing how changes of the parameters of the economic system can affect the incompliance behaviour and so the size of the underground economy.

2. Evaluating redistribution of welfare among the classes of economic agents (employers, employees, and the government) as a result of the tax reform introduction.
3. On the basis of investigation of the ties and effects above, developing policy recommendations for further reforming the PIT system in Ukraine and introducing the policy capable of efficiently affecting tax evasion.
4. In the framework of the research, we develop a general methodology, relevant to personal-income tax response analysis in the Ukrainian context. Besides, the tax reform under way in Ukraine in a way is a natural experiment. This provides a theoretical interest and gives a good ground for researching the behavioural effects of these changes.

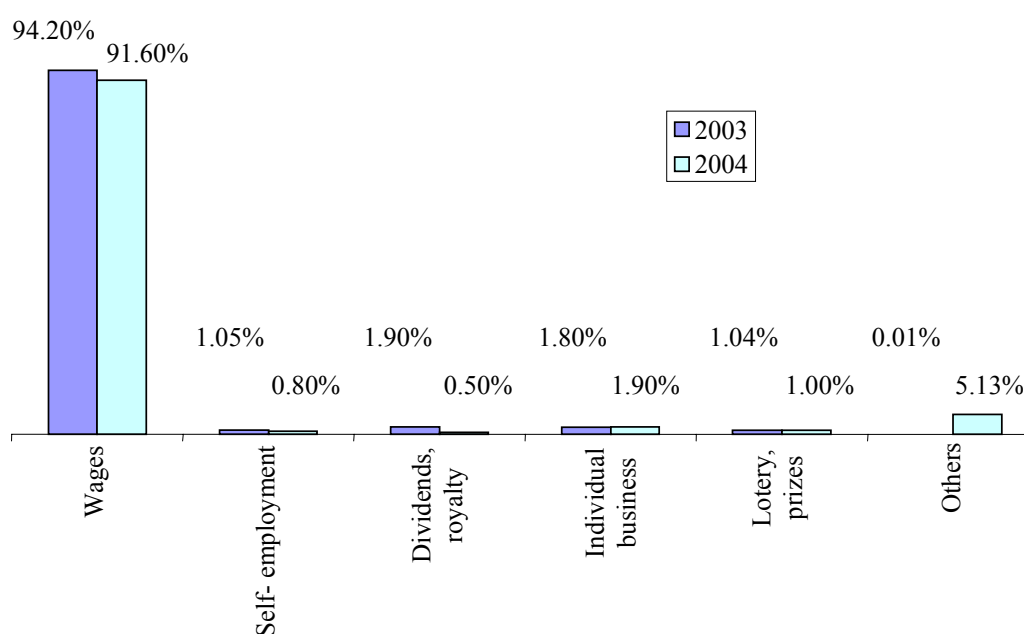


Fig. 2. Components of the PIT revenues⁵

1.1. Hypotheses

1. *The low flat tax rate on personal income lead to increasing declared labour income (both wage rate and registered jobs).* The substantially lower PIT rate stimulates employers to report a bigger part of actually paid wages without increasing their expenditures on labour.
2. *Introducing the low flat tax rate on personal income lead to decreasing PIT revenues.* PIT revenues may decrease considerably since the amount of de-shadowing labour income may ap-

⁵ Source: *Finance of Ukraine* No. 10, p. 38 (2005).

pear not enough to compensate for the cut in the tax rate. The primary goal of the tax reform is to transmit a part of the labour income out of the shadow increasing the base for PIT subtractions. Still, a certain decrease in PIT revenues is expected since the new PIT rate is lower than the former effective PIT rate (15%).

3. *Income is redistributed from the government to employers as a result of the tax reform.* Still the actual employees' income is the paid wage agreed on by employer and employee preliminary. Cutting in PIT rate allows the employer to reduce expenditures even if they decide to report a bigger part of the wage paid.

1.2. Research strategy

The research approach adopted involves constructing theoretical general equilibrium model adapted to practices in the Ukrainian economy. Solving the model analytically shows how the structural peculiarities put into the assumptions of the models condition the consequences on the tax reform under investigation. This allows a preliminary analytical testing of the hypotheses formulated. Empirical testing of the hypotheses on the firm-level data that follows reveals actual effects of the reform and confirms adequacy of the theoretical model and validity of the assumptions adapted.

The theoretical model developed consists of two parts: short run and long run. As far as hypotheses formulated refer to only short-run consequences of the reform introduced, testing them is provided within the simplified short-run model, as well as in the empirical part. Long-run model allows finding equilibrium path of tax and fine rates, share of reported wage and other state and policy variables for the players involved: the government, the firm, and the tax officer. The long-run model results hold under the condition of invariable structural ties and practices in the economy.

2. REVIEW OF CONCEPTUAL FRAMEWORK

In theory, taxes levied on personal incomes induce individuals to respond in two ways. First of them is to seek different consumption bundles or to adjust their working hours. However, this substitution response, as suggested by Slemrod (1998), is not sensitive to tax rate changes. More often, people undertake a variety of tax planning schemes and other manipulations, whose goal is to reduce tax liability without changing consumption. Tax avoidance techniques⁶ or substituting away to untaxed activities, leisure or household production,⁷ are legal forms of reducing tax liabilities; while tax evasion and activities in the underground economy are subject to detection and punishment by the government. Generally, each of these behavioural forms is typically perceived by economists as a rational response of an individual maximising their income or consumption.

⁶ for a detailed examination see Slemrod (1998).

⁷ for interesting explanations see Davis and Henrekson (2004).

The choice to evade taxes, completely or partially, is usually modelled in the theory as comparing benefits from the underreporting taxable income with costs of risks and penalties if detected. The basic theoretical model explaining tax evasion is a straightforward application of a rational individual's choice under uncertainty, first described by Allingham and Sandmo (1972). Since that time, the theoretical framework of tax evasion has developed into a two-sector model incorporating the conventional labour-supply theory; and then — into the general equilibrium model with production, markets, and many interacting participants. The latter refers to the study of the underground economy.

The turning point in tax evasion discussions was Clotfelter (1983) conclusion that the opportunity to evade taxes depends on the source of income (capital income, a salaried position in a corporation, self-employment). Since decisions on income concealment are closely related to labour market choices, the tax evasion decisions are studied in the conventional framework of labour-supply models.

But the labour-supply choice alone cannot be determinative for the allocation of labour between the formal and informal sectors — demand for labour is expected to matter as well. Intuitively, taxes levied on labour income create a gap between gross wages paid by employers and net wages received by employees; with higher tax rates this gap may become large enough to induce both of them to participate in the underground.

The traditional framework of the general equilibrium model involves, on the one side, labour force participants looking for jobs, and, on the other side, productive firms looking for employees. A potential employee makes a decision to supply their labour services at one of the markets comparing the net marginal return on their work in both sectors maximising their expected income. Too high tax rate on labour income makes the net return on an individual's work efforts in the official sector unsatisfactorily low and induces them to look for higher return by evading taxes in the informal sector. On the other hand, the employer makes the decision to propose a job at one of the two markets depending on the net marginal return from a labour unit in both sectors. The expenses on a labour unit consist of official wage rate and payroll tax in the formal sector; while in the informal sector, — of unofficial wage rate and expected penalty for the unregistered job. So, increasing payroll tax may drive up the labour expenses to some critical level, after which they overweight the return from labour. To minimise the costs firms are induced either to hire less labour or to hire labour informally to escape paying taxes. Both the employer and the employee meet in either formal or informal labour market, where wages are established as a result of both sides interacting under the condition of markets clearing.

According to empirical observations, provided by Clotfelter (1983), Kesselman (1989), Henrekson (2004) and many others, the tax policy effects are hinged on the production technology in a certain industry and influence considerably the scale of underground businesses, their mode of operation, and, again, their production technologies. This stresses the importance of the demand channel effects of personal income taxes on the underground economy. Correspondingly, labour demand responses to changes in policy instruments; while labour supply adjusts to the new equilibrium. The magnitudes of responses and adjustment are represented by labour supply-demand elasticities.

The theory, described by Davis and Henrekson (2004), identifies characteristics of production technologies and factor input that lead to high or low tax responsiveness. Key factor here is how access to capital markets and scale of economy that may be enjoined only in the formal sector are determinative for productivity of the enterprise accordingly to its technology. Firms, operating informally, have a limited access to the means of contract enforcement, so they are constrained in borrowing from capital markets. Consequently, these firms choose to enter formal sector when their return on outside financing exceeds the additional tax costs they must bear. Besides, informal firms must restrict the size of their operations to minimise the chance to be discovered. Similarly, those firms that can enjoy the economies of scale effect in their production rather prefer the formal sector. Therefore, we can characterise the firms relatively insensitive to tax changes as the ones with capital-intensive production technology or/and with large establishment.

According to Amaral and Quintin (2003), in the equilibrium, participants of the underground tend to be more productive in those occupations or industries that are more amenable to tax evasion. Increasing tax rates on the labour income induces primarily firms with labour-intensive technology to switch to the underground, and enhances their demand for low-skilled labour.

In the context of this study a special interest for Ukrainian researchers and policy-makers lies in the results of research on the Russian tax reform.

The major assumption providing the ground for both Russian and Ukrainian reforms is that the tax burden is too heavy, therefore, the major stimulus for tax evasion is high tax rates,. Besides, the progressive tax rate was recognised to fail in fair income redistribution in the society. Thus, the instituted flat rate is expected to encourage de-shadowing firstly high income, that is expected to improve PIT revenues and simultaneously to restore social fairness.

Russian reform is generally regarded as a successful one as its introduction led to a slight rise in PIT revenues. Russian reform was investigated in a number of research papers, such as Sinelnikov and Moreliov (2003) and Vasilyeva and Gurvich (2003). Researchers of the Russian tax reform generally performed their study applying models on aggregated macro data.

The main objective of researches on the Russian reform was to establish a connection between the tax rate and the tax base (detecting the de-shadowing effect of the reform) and between the tax rate and the tax revenues (detecting whether the tax base could compensate for the tax rate reduction). Sinelnikov and Moreliov (2003) tested the corresponding hypotheses on highly aggregated data across regions of Russia. They found a significant, but small positive effect of the tax rate cut on tax revenues and the tax base. Still, the connection found is likely to be interpreted as a correlation between indicators since factors of PIT revenues, PIT base, and PIT rate were just regressed one against the other, which is not sufficient to reveal any causal ties. Thus, the effects could have been caused by other factors in the economy and just happened in the same time. Unfortunately, no other factors were analysed in the study.

In the contrast, Vasilyeva and Gurvich (2003) provided a detailed analysis of all possible tax reform effects and considered a number of economic factors, which could appear to cause the PIT

base extension altogether with the PIT revenues. Authors considered in their analysis such factors as the economic growth in the country, increased demand for labour, increased labour productivity, de-shadowing, indirect influence of other tax changes and others. They estimated the weighted contribution of each factor to the increase of the average wage rate with the production function model of the general Cobb–Douglass presentation. In conclusion, the increase in official wages by 3.2% of GDP was explained by the following factors: decreasing in turnover taxes (0.4%), decreasing in social tax (1.3%), de-shadowing wages (0.7%), structural economic factors (0.9%). Thus, the main factor of increasing PIT revenues in Russia is recognized to be the simultaneous reforms of other important taxes such as the enterprise profit tax, turnover tax and social tax. Also, authors claimed that no proof could be found that the effect of de-shadowing was provoked by the cut in the PIT rate.

Refereeing to the same argumentation, IER experts⁸ state that Ukrainian and Russian reforms cannot be compared. In the analysis, IER pointed out that sharp cut in the tax rate would rather lead to a significant decrease in the revenues and financial instability since the before-reform effective tax rate is actually higher than proposed one. They highlighted that transparency and simplicity of legislation norm, exemptions, doubtful definitions and privileges, are more preferable tools for tax base widening. Anyway, cut of tax rate should be implemented gradually, step-by-step, to control financial stability.

ICPS experts⁹ analysed the problem in the general context of the whole economy. They highlighted the role of tax legislation predictability, share of social tax in total labour expenses, corruption, legal norms regulating business, development of financial markets, and satisfactory public services. They state that the problem could be solved as a result of the structural reforms improving the general balance of advantages of participating in the official economy in comparison to the benefits from tax evasion activities.

Leading analytical institutions mentioned high tax burden, in particular marginal tax rate, but all of them do not as the most important factor of PIT evasion. Other factors, in the first stage, tax legislation, tax administration, definitions of the tax base and tax payers. These conclusions coincide with those made by IMR experts¹⁰ that tax evasion behaviour is not sensitive to tax rate changes in the transition country because of more serious structural problems in the economy.

We agree with the point that informality is an outcome of non-trivial interactions between various kinds of institutions (fiscal institutions, labour markets). And to trace and distinguish between effects of various factors in researching we need to apply the general equilibrium structural model. Only through a thorough understanding of all these interactions, a government can choose an effective way leading to any considerable reduction in the scale of the shadow sector of the economy.

⁸ IER (Institute of Economic Research, Kyiv) Working Paper (2002).

⁹ ICPS (International Center for Policy Studies) Analytical Note (2003).

¹⁰ Stepanyan (2003).

3. DATA SPECIFICATION

The micro data necessary for the analysis can be found in financial reports (income statement and balance sheet), and statistical forms (Form Entrepreneurship) companies provide to local statistics offices. The data series obtained are listed in the Appendices A2 and A3. Appendix A4 presents descriptive statistics for the data series.

Micro data are costly and a special attention is paid to the process of retrieving the data from the database. Some companies do not have employees; others do not disclose the information on wage fund, and so on. In addition to the data cited, available can be also other variables from the forms noted above; also available can be international trade activities by the companies (volumes of exports-imports).

Totally in Ukraine there were 935578 companies registered in 2003. Still, according to the SSC information, in 2003 there were 247413 actually operating companies (those submitting statistical, balance, and financial forms). So the representative number of companies in the sample was calculated on the basis of this figure with the following formula:

$$n = \frac{ft^2\sigma^2N}{N\Delta^2 + t^2\sigma^2}, \quad (1)$$

where n is the sample size wanted, $N = 247413$ — the population of companies; $\sigma^2 = 0.25$ (maximum value); $\Delta = 0.05$; $t = 2$ (for $P = 0.9545$). f is the number of sub-samples which have to be representative. Taking $f = 3$ we get the possibility to analyze the data in three cuts: according to the industry, region, and form of ownership.

For these figures the wanted value of n is at least 1198, and we take 1200.

According to the Ukrainian law it is prohibited to disclose financial and other data of individual companies. So the statistics office can provide only information according to preliminary stated criteria without names or individual numbers of companies.

The criteria of representativity chosen were those of industry, region, and the form of ownership. The figures were calculated on the SSC report for the beginning of 2003 about the total number of the companies (registered) under the assumption of the proportion of really active companies to the total amount across all of the criteria listed in Appendix A2.

Prior to the econometric analysis micro data for 2004 were deflated to be consistent with the price level of 2003 by the index of inflation.

4. SHORT-RUN MODEL

4.1. Developing the model

The general assumption of the model is that firms operate both in the regular economy, as well, as in the shadow. Some of the employees are employed officially, and some of them are hidden labour.

In the framework of the model this is equivalent to all the workers being employed officially, with their wages reported only partly, which also corresponds to the real state of the economy.

To build the model in the short run, it is possible to consider only the firm side. On the side of the firms, employers are assumed to be the only party responsible for paying taxes. The reasoning for the assumption is that in terms of Ukraine in transition, with the employer paying all the taxes and other charges calculated on top of the wage fund, with no deficit of labour force, and poorly developed labour and social insurance markets, the employee is interested in and bargains about only net wage they receive, which is assumed the only incentive for employment. We assume that the demand channel strictly dominates in the market since the labour market is characterised by endogenous skills and high unemployment costs. (Actually, it is true for many professional segments of labour market in Ukraine). So, we do not incorporate employees' problem into the model. The net wage is resulting from the demand-supply equilibrium and is exogenously set in this model.

Under competition assumption, it would be plausible to treat enterprises as one agent. The firm chooses the proportion of its legal and shadow parts.

The government collects taxes for public services (such as defence, road construction, etc, which are assumed to have no influence on the structure of the externally determined income of the firm) and for transfers to the poor (which are assumed to have no influence on the exogenously set net wage the employee gets paid).

In this, the employer decides on the amount of the wage to report according to their belief of probable response by the tax officer. The firm pays to its employees the net salary of W , but reports W_r , which takes the values of $[0, W]$. In normalised terms, it reports the w_r part of it. w_r takes only values of $[0, 1]$. The firm has also a set of beliefs of the probability of audit and audit efforts of the tax officer. The probability ρ is defined as depending on the following factors:

- the fine rate of θ (positively: the higher the fine rate, the more auditing effort will be applied with tax officer potentially able to get more personal benefits from the audit);
- the ratio of the net wage paid to the industry average net wage W_r / \bar{W} (inversely with 92% of fines by tax administration statistics is levied on the companies reporting less than their region industry average wage);
- the ratio of the net wage paid to the minimum wage W_r / W_{\min} (inverse dependence with below minimum wage set by the parliament for the period reporters being almost necessarily audited);
- the reported employees' salary of w^r (reflecting subjective feeling of guilt for the employer underreporting employees' wages).
- In so we get ρ as a subjective reflection of the tax officer's effort. In case the firm gets caught, it must pay the rest of the tax of $t(1 - w^r)$ and the fine of $\theta(1 - w^r)$.

Under these assumptions the firm's objective function looks in the following way:

$$\min_{w^r} T^r + \rho \times ((T - T^r) + \Theta), \quad (2)$$

Here taxes paid on the wage fund are

$$T = T(W), \quad (3)$$

the amount of tax to be paid is

$$\Theta = \Theta(T - T^r), \quad (4)$$

and the subjective probability (firm's beliefs) of being caught is

$$\rho = \rho(w^r, \theta, \frac{W^r}{\bar{W}}, \frac{W^r}{W_{\min}}), \quad (5)$$

The assumptions of the functional form of the probability function look graphically in the following way (see Fig. 3):

$$a) \rho\left(\frac{W_r}{W}\right) = \left(1 - \sqrt{1 - \left(1 - \frac{W_r}{W}\right)^2}\right);$$

$$b) \rho\left(\frac{W_r}{\bar{W}}\right) = \left(\frac{0.92 + 0.08\sqrt{1 - \left(\frac{W_r}{\bar{W}}\right)^{2k_1}}}{\left(\sqrt{\frac{W_r}{\bar{W}}}\right)^{1-k_1}}\right),$$

$$\text{here } k_1 = \begin{cases} 0, W_r \leq \bar{W} \\ 1, W_r > \bar{W} \end{cases}, \text{ or, in programming terms, } k_1 = \frac{1}{2}(1 - \text{sign}(W_r - \bar{W}));$$

$$c) \rho(\theta) = \left(\frac{\theta}{\theta + 1}\right);$$

$$d) \rho\left(\frac{W_r}{W_{\min}}\right) = \left(\frac{W_r}{W_{\min}}\right)^{-k_2},$$

$$\text{here } k_2 = \begin{cases} 0, W_r \leq W_{\min} \\ 2, W_r > W_{\min} \end{cases}, \text{ or, in programming terms } k_2 = 1 - \text{sign}(W_r - W_{\min}).$$

With these assumptions on the functional form, the probability of being caught takes the following form:

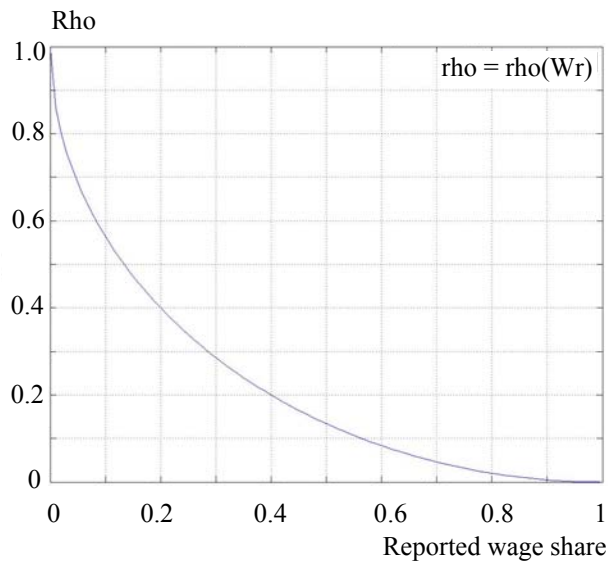
$$\rho = \left(1 - \sqrt{1 - \left(1 - \frac{W_r}{W}\right)^2}\right) \times \left(\frac{0.92 + 0.08\sqrt{1 - \left(\frac{W_r}{\bar{W}}\right)^{2k_1}}}{\left(\sqrt{\frac{W_r}{\bar{W}}}\right)^{1-k_1}}\right) \times \left(\frac{\theta}{\theta + 1}\right) \times \left(\frac{W_r}{W_{\min}}\right)^{-k_2}. \quad (6)$$

When inserting these formulas into the objective function we ultimately get:

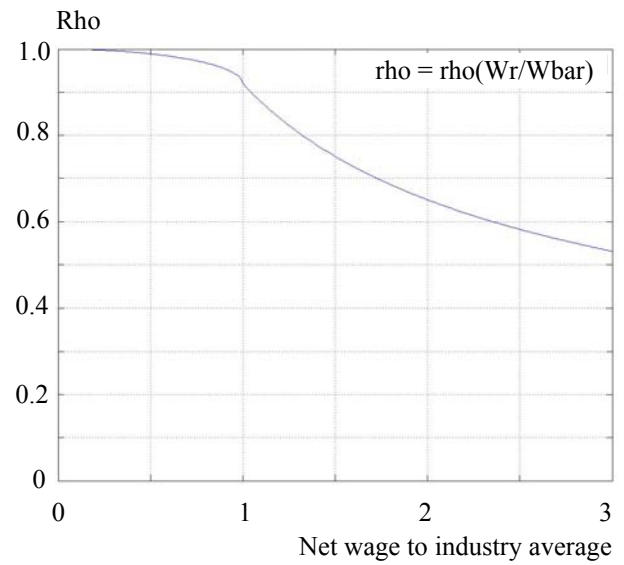
$$\min_{W^r} \left[t(W_r)W_r + b(W_r) + \left(1 - \sqrt{1 - \left(1 - \frac{W_r}{W} \right)^2} \right) \times \frac{0.92 + 0.08 \sqrt{1 - \left(\frac{W_r}{W} \right)^{2k_1}}}{\left(\sqrt{\frac{W_r}{W}} \right)^{1-k_1}} \times \right. \quad (7)$$

$$\left. \times \left(\frac{W_r}{W_{\min}} \right)^{-k_2} \times \theta \times \dots \times (t(W) + b(W) - t(W_r)W_r - b(W_r)) \right],$$

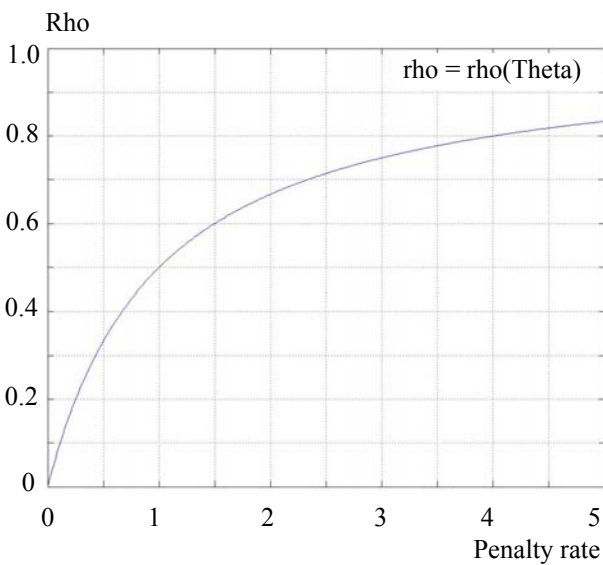
s.t. $W^r \leq W; W, W^r \geq 0$.



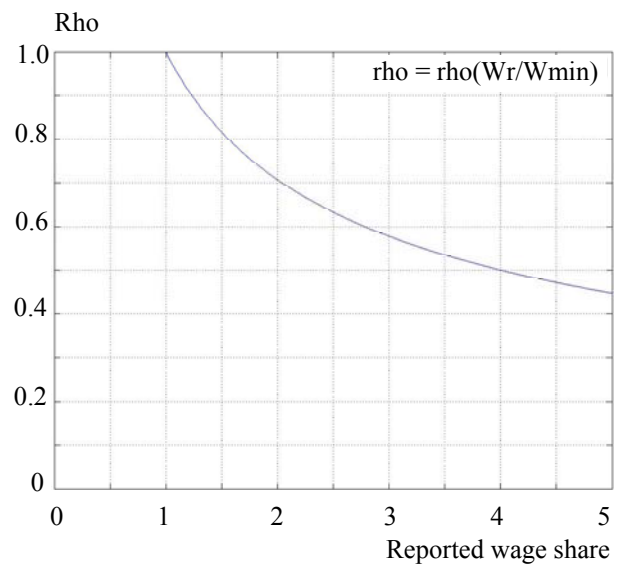
a) Probability of detection on reported wage



b) Probability of detection on ratio to industry average



c) Probability of detection on penalty rate



d) Probability of detection on ratio to minimum wage

Fig. 3. Assumptions on the functional form of the probability function

The model is built on the basis of the net wage received by the employee. So all the wages were recalculated into the net form (including minimum wage, industry average wage, etc). The taxation system (the amount of net taxes paid) in both 2003 and 2004 in Ukraine can be represented in the following functional form:

$$T = t \times W + b, \quad (8)$$

where t and b have several different values depending on W , calculated from the PIT system (Appendix A1) and is presented in the table below:

2003								
W	≤ 18	$\leq 77,38$	$\leq 130,45$	$\leq 145,35$	$\leq 799,85$	$\leq 1255,45$	$\leq 1802,65$	$> 1802,65$
t	0.3680	0.55455	0.64819	0.66829	0.77662	1.04179	1.40000	0.75439
b	0.00000	-2.64273	-9.80675	-9.92634	-25.67221	-237.76657	-687.48000	476.33614

2004					
W	$\leq 154,185$	$\leq 317,2665$	$\leq 437,4135$	$\leq 2233,203$	$> 2233,203$
t	0.60450	0.62105	0.62944	0.62944	0.19111
b	-14.83043	-14.98332	-15.06095	0.00000	978.88

A graph built on these data is displayed in Fig. 1.

Concerning fines, they can be modelled in the following way:

$$\Theta = \theta \times (T(W) - T(W')). \quad (9)$$

According to the law of Ukraine "On the order of paying liabilities by taxpayers to budget and non-budgetary special funds," dated December 21, 2000, companies caught evading taxes must pay the due payment, penalty, and interest on the payment and penalty.

Before February 20, 2003 the amount of penalty was 200% and since the date — not more than 50% of the discovered overdue payment. So we can assume the formal penalty system to be identical in the both years of 2003 and 2004.

The interest is calculated as yearly 120% of the National Bank's rate (7% in 2003 and the average of 7.417% in 2004). Legally allowed audit for a company by tax authorities cannot date further back than 3 years. This leads to the average interest of 12.6% for overdue payments originating in 2003 and 13.31% for those from 2004.

So from these data we obtain $\theta = 0.626$ in 2003 and $\theta = 0.633$ in 2004.

These assumptions allow building a model for researching through the optimal response of firms to the taxation system set. The Matlab program for running estimation for the 2003 ('old') system, 2004 ('new') system and objective realized as a separate function are given in the Appendix A2. the

calculations were done for a particular industry — Real estate operations, lessor activities, and services for legal entities, growing in the average wage from UAH 526.81 (the net of 420.09) in 2003 to UAH 666.77 (the net of UAH 559.79) in 2004.

The minimum wage grew from UAH 185 in 2003 to the average of 215.67 in 2004, or from UAH 156.90 to UAH 191.25 in the net terms. This is reflected in the simulation program.

Numerical calculations produces $W_r^* = W_r^*(W)$, from where it is possible to calculate and compare the optimal relative response

$$w_r^* = \frac{W_r^*}{W}.$$

The results of estimation are reported in the charts below (see Figs 4, 5).

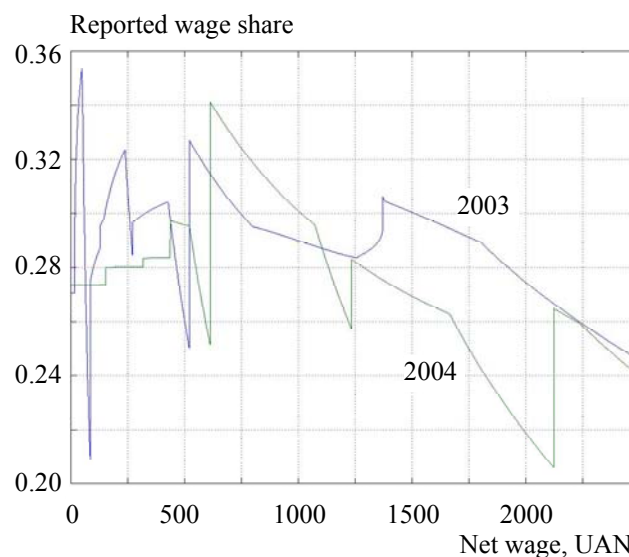


Fig. 4. Comparing the share of reported wage in 2003 and 2004

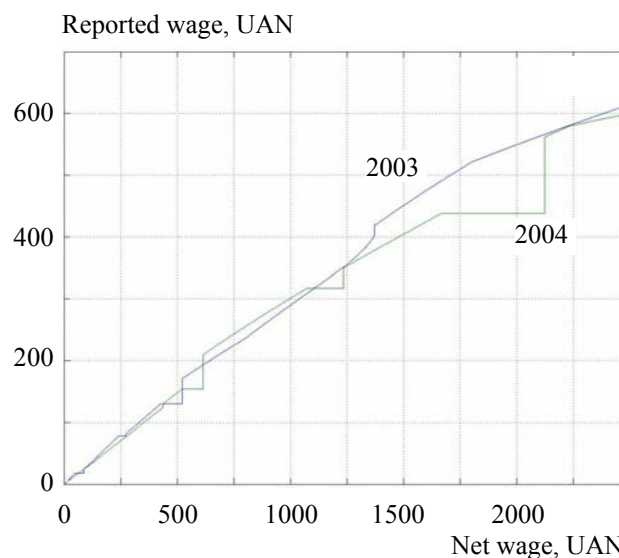


Fig. 5. Comparing the volumes of reported wage in 2003 and 2004

The figures show the behaviour the firm in 2003 and 2004 in comparison. Difference in the reported wage share is given in the Fig. 6.

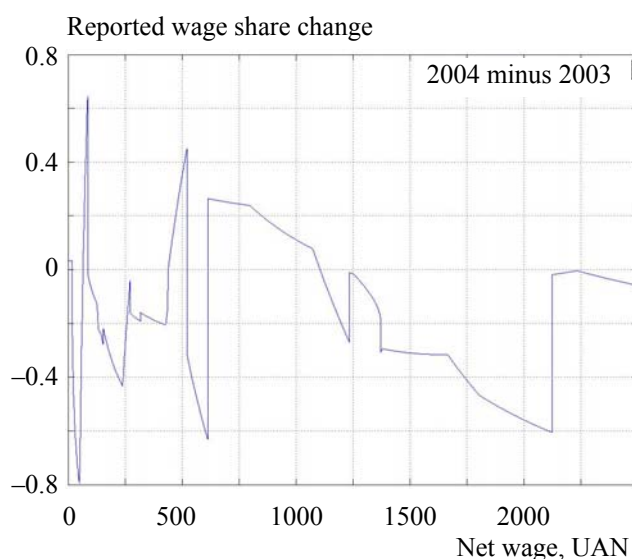


Fig. 6. Difference in the reported wage share 2004–2003

The figure shows that for the net wage under 1750 the 2003 system was no less efficient in collecting taxes than the 2004 one.

The numerical estimation shows that the reported wage share fluctuates around 28%. As far as the model covers those companies which are able to respond to the existing market conditions (make good use of the rules of the game) it would be plausible to assume that it is mostly private-owned companies that underreport wages. Considering that out of all employees in Ukraine in 2004, 47.2% worked for private companies and 52.8% — for state-owned and municipal companies and institutions, and assuming that underreporting were private companies and public ones behaved in the legal way, we ultimately get the reported wage share of $52.8\% + 47.2\% \times 0.28 = 66\%$, which produces estimate of the shadow sector of the economy of 34%. This is consistent with joint estimates by the Ministry of Economy and the World Bank of 35% in Ukraine in 2004.

4.2. Testing hypotheses

In this numerical model set-up it is possible to test the hypotheses.

Hypothesis 1.

For the first hypothesis testing we can eliminate in the model the effect of the minor penalty system change, the growth of the minimum wage and also the effect of the industry average wage on the reported wage. From the assumption which was laid into the basis of the study that the employee is interested in the net wage only we can presume the employer paying the same net wage to the employee and test the hypothesis.

The results of the simulation look in the following way (see Figs 7, 8).

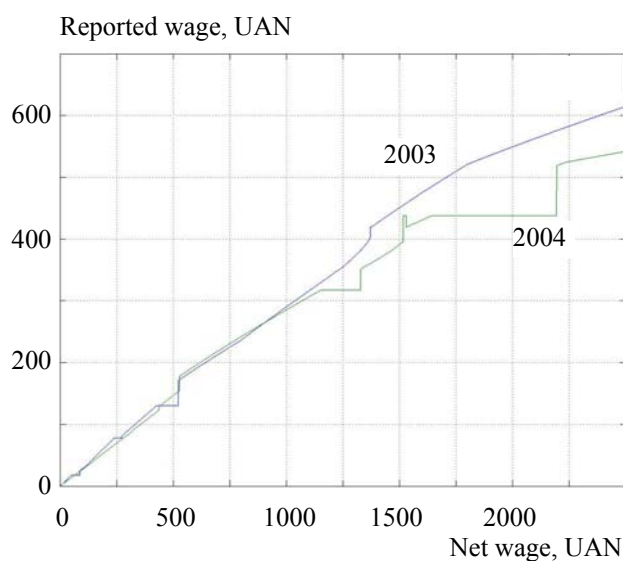


Fig. 7. Results of testing Hypothesis 1

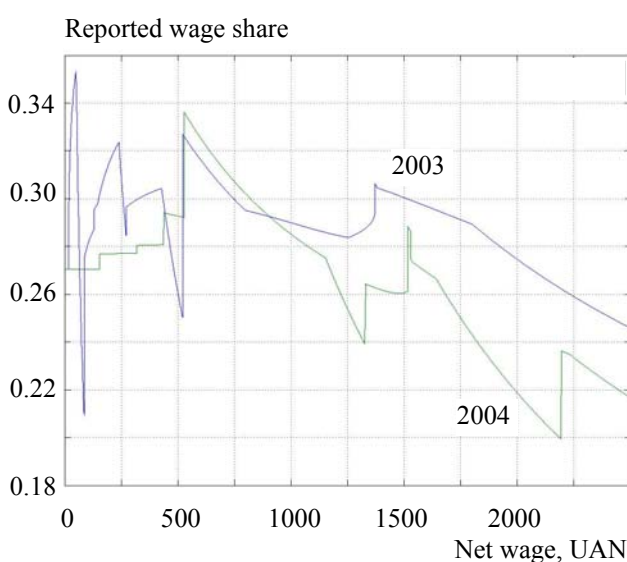


Fig. 8. Results of testing Hypothesis 1

From the charts it is obvious that unless the net wage distribution is very much concentrated around UAH 600 (which is definitely not the case in the economy), the change in the tax itself did not cause any de-shadowing effect.

This suggests the conclusion that decreasing taxes in itself cannot stir any de-shadowing. In this case with the penalty system unchanged, the firm can increase its wealth by reporting a smaller share of taxable expenses with presuming the same level of risk.

When combined with the rest of changes in the economy, the ultimate effect can be calculated taking into consideration the distribution of wages. Taking the sub-sample of private ownership companies from the data set at hand (810 companies in each year) and deriving the net wage series from

the wage fund, number of employees and the set of taxation system rules, we get the following net wage distribution in 2003–2004 (see Fig. 9).

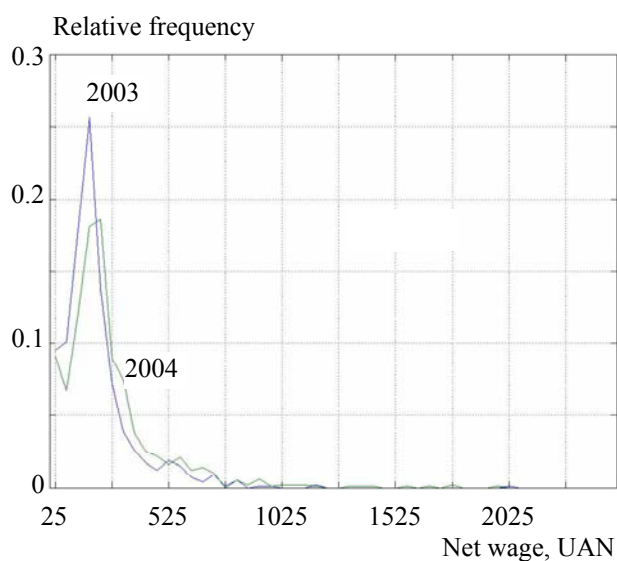


Fig. 9. Net wage distribution for private companies

Using the distribution as weights for the series of reported wage shares obtained as a result of the simulations, we get the average reported wage for 2003, which is 0.27, and the one for 2004, which is 0.31. From these data we estimate the contraction of the shadow sector from 2003 to 2004 to be about 1.7%.

Hypothesis 2.

Despite the fact that the average reported wage share grew and nominal wage grew considerably, this may not be enough to compensate for the losses that are incurred by the government when reducing the effective PIT rate from about 15% to less than 13% (because of privileges remaining).

To numerically estimate the effect we generate the series of governmental revenues (from the set of taxation rules) and use weights from the distribution (shown in the figure above).

From these calculations we get average budget revenues from one employed person to be 29.11 in 2003 and 30.29 in 2004. Discounted by the real wage index (5.7%) in 2004, the revenues of 30.29 turn into 28.66 stipulating the loss in income of UAH 0.45 (in terms of 2003 money). So the hypothesis holds.

Hypothesis 3.

Hypothesis 3 holds under the model assumptions and the results above from testing hypotheses 1 and 2 with UAH 0.45 being transferred per employee per month from the government to employers.

Testing hypotheses on the theoretical model provided a preliminary result of absence of any consistent proof of more incentives for firms to report taxes in the changing the tax rate alone. Also, the reform lead to falling real revenues from PIT collections with redistribution of income from the government to employers.

5. LONG-RUN MODEL

5.1. Specifying the model

In the long run, the modelled economy consists of three agents: government, the firm and the tax officer.

Government's objective is to maximize social welfare, which is the total output Y .

The government sets tax rates τ and collects taxes and fines $(T + \theta)$; collected proceeds are used to produce a public good P and are put back into the economy at a transaction cost of C : $P_t = T_{t-1} + \theta_{t-1} - C_{t-1}$. Public good represents enforcing property rights and other services by the government available only to firms operating legally. It fully depreciates after one period. So, the Government's objective function is maximizing social welfare consisting in the sum of labour income over reservation wage plus net income of companies (less necessary investments) less costs of running the economy:

$$\max_{\{\tau_t, \theta_t\}} \sum_{t=0}^{\infty} \beta^t (L_t(W_t - W_{res_t}) + (Y_t - L_t W_t(1 + \tau_t) - I_t) - C_t) \quad (10)$$

The firm is a representative agent of a big number of identical ones. The firm produces under the CRS neoclassical production function. The factors of production are technology shock A , labour input L , capital K , and public good P :

$$Y_t = A_t P_t^\alpha K_t^\gamma L_t^{1-\alpha-\gamma}.$$

Technology shock A_t follows one-period Markov process pattern:

$$A_t = aA_{t-1} + \varepsilon_t^A.$$

Capital K_t wholly belongs to the firm and no rent is paid for using that. The firm invests a part of its profits in production:

$$K_t = K_{t-1}(1 - \delta) + I_{t-1}.$$

Public good is a factor of production invested by the government:

$$P_t = W_{t-1}^r L_{t-1} \tau_{t-1} + c_t (W_{t-1} - W_{t-1}^r) L_{t-1} (\tau_{t-1} + \theta_{t-1}) - C_{t-1}.$$

Labour and product markets clear exogenously. The assumption goes that labour is in sufficient supply in the market and search can be performed costless at any moment. The only tax in the modelled economy is levied on labour income. The firm is fully responsible for paying these taxes.

Firm is a representative of a big number of identical agents operating in the economy. Firm maximizes its value as a stream of its net income stream left after producing and paying labour expenses and taxes less capital investments necessary for production in the following periods. The firm pays wage W but shows to the government only the a part of that W^r — reported wage. So the total ex-

penses the firm is willing to pay are $(W + W^r \tau)$. The firm expects a fine of the size of $(W - W^r)(\tau + \theta)$ in case it is caught evading with the perceived probability of ρ . It is assumed that in case the firm is caught, all of the hidden part of wage $(W - W^r)$ is revealed. So, the firm's objective function is:

$$\max_{\{W_t^r, K_t\}} \sum_{t=0}^{\infty} \beta_f^t \left(Y_t - L_t W_t - \tau L_t W_t^r - \rho_t (L_t W_t - L_t W_t^r)(\tau_t + \theta_t) - I_k \right). \quad (11)$$

The tax officer targets at maximising proceeds from fines and extra payments to the state budget minus value of audit C . Value of audit is equal to the intensity of audit $c = [0,1]$ times cost of unit of audit ψ : $C_t = c_t L_t W_t \psi_t$. The set audit effort to be identical with the probability of detection. So the tax officer has the following objective:

$$\max_{c_t} \left(c_t (\tau_t + \theta_t) (W_t L_t - W_t^r L_t) \varepsilon_t^c - C_t \right), \quad (12)$$

where $(W_t L_t - W_t^r L_t) \varepsilon_t^c$ is the officer's guess on the amount of hidden wage. ε^c is an error term following log-normal pattern of $(0, \sigma_c^2)$. To simplistically model the learning process, we assume

$$\sigma_t^2 = \varsigma_c \sigma_{ct-1}^2.$$

In per capita per unit of wage terms, the economy incentive structure looks in the following way:

Government:

$$\max_{\{\tau_t, \theta_t\}} E \sum_{t=0}^{\infty} \beta^t \left(1 - \frac{Wres_t}{W_t} + (y_t - 1 - \tau_t) - i_t - c_t \psi_t \right). \quad (13)$$

Firm:

$$\max_{\{w_t^r, k_t\}} E \sum_{t=0}^{\infty} \beta^t \left(y_t - \tau_t w_t^r - \rho_t (1 - w_t^r)(\tau_t + \theta_t) - i_t \right). \quad (14)$$

Tax officer:

$$\max_{c_t} E \left(c_t (\tau_t + \theta_t) (1 - w_t^r) \varepsilon_t - c_t \psi_t \right). \quad (15)$$

Here

$$y_t = A_t p_t^\alpha k_t^\gamma, \quad p_t = \frac{1}{l_t v_t} (\tau_{t-1} + c_t (\tau_{t-1} + \theta_t)),$$

$$l_t = \frac{L_t}{L_{t-1}}, \quad v_t = \frac{W_t}{W_{t-1}}, \quad k_t = \frac{K_t}{L_t W_t}, \quad w_t^r = \frac{W_t^r}{L_t W_t}, \quad E(\varepsilon_t^c) = \exp\left(\frac{\sigma_{ct}^2}{2}\right).$$

The model has inbuilt the following incentive structure. The government is interested in rising the tax rate as long as additional increment will spur public welfare stream. The government is con-

scious of both positive and distortion effects of taxation on private production. The firm's incentive structure may be split into short run and long run. In the short run, the firm is interested in hiding. Its one-period objective is identical to minimizing costs. The firm is unconscious about positive effect of taxation and it is small to affect taxes or creation of public good. In the long run, it is interested in optimising investments to achieve its maximum value. The tax officer optimizes efforts in order to reach maximum positive result of audit activities.

5.2. Solving the model analytically

Mixed strategies lead to the following equilibrium conditions:

From tax officer's objective:

$$w_t^r = 1 - \frac{\psi_t}{(\tau_t + \theta_t) \exp(0.5\sigma_t^2)}.$$

From company's objective of minimizing costs:

$$\rho_t = \frac{\tau_t}{\tau_t + \theta_t}.$$

Applying the non-degenerate equilibrium condition, $c_t = \rho_t$. Further, it can be shown that

$$\tau_t w_t^r + \rho_t (1 - w_t^r)(\tau_t + \theta_t) = \tau_t, \quad p_t = \frac{1}{l_t v_t} \left(\tau_{t-1} - \frac{\tau_{t-1} \psi_{t-1}}{\tau_{t-1} + \theta_t} \right).$$

Eliminating the terms that are exogenous from the objective functions of corresponding agents, we get the following system of optimisation problems:

Government:

$$\max_{\{\tau_t, \theta_t\}} E \sum_{t=0}^{\infty} \beta^t \left(A_t p_t^\alpha k_t^\gamma - \tau_t + k_t(1 - \delta) - k_{t+1} l_{t+1} v_{t+1} - c_t \psi_t \right). \quad (16)$$

Firm:

$$\max_{\{k_{t+1}\}} E \sum_{t=0}^{\infty} \beta^t \left(A_t p_t^\alpha k_t^\gamma + k_t(1 - \delta) - k_{t+1} l_{t+1} v_{t+1} \right). \quad (17)$$

Solving the firm's optimisation, we get:

$$-l_{t+1} v_{t+1} + \beta E(A_{t+1}) p_{t+1}^\alpha k_{t+1}^{\gamma-1} + \beta(1 - \delta) = 0,$$

from where

$$k_{t+1} = \left(\frac{\beta E(A_{t+1}) \gamma}{l_{t+1} v_{t+1} - \beta(1 - \delta)} \right)^{\frac{1}{1-\gamma}} p_{t+1}^{\frac{\alpha}{1-\gamma}},$$

or, letting

$$\varphi_{t+1} = \left(\frac{\beta E(A_{t+1}) \gamma}{l_{t+1} v_{t+1} - \beta(1 - \delta)} \right)^{\frac{1}{1-\gamma}},$$

we get

$$k_{t+1} = \varphi_{t+1} p_{t+1}^{\frac{\alpha}{1-\gamma}},$$

which when plugged into the government's objective modifies it in the following way:

$$\max_{\{\tau_t, \theta_t\}} E \sum_{t=0}^{\infty} \beta^t \left(A_t \varphi_t^\gamma p_t^{\frac{\alpha}{1-\gamma}} - \tau_t + \varphi_t p_t^{\frac{\alpha}{1-\gamma}} (1-\delta) - \varphi_{t+1} p_{t+1}^{\frac{\alpha}{1-\gamma}} l_{t+1} v_{t+1} - c_t \psi_t \right) \quad (18)$$

where

$$\begin{aligned} p_{t+1} &= \frac{1}{l_{t+1} v_{t+1}} \left(\tau_t - \frac{\tau_t}{\tau_t + \theta_t} \right), \text{ and } c_t = \frac{\tau_t}{\tau_t + \theta_t}; \\ \frac{dp_{t+1}}{d\tau_t} &= \frac{1}{l_{t+1} v_{t+1}} \left(1 - \frac{\theta_t}{(\tau_t + \theta_t)^2} \right), \quad \frac{dp_{t+1}}{d\theta_t} = \frac{1}{l_{t+1} v_{t+1}} \frac{\tau_t}{(\tau_t + \theta_t)^2}; \\ \frac{dc_t}{d\tau_t} &= \frac{\theta_t}{(\tau_t + \theta_t)^2}, \quad \frac{dc_t}{d\theta_t} = -\frac{\tau_t}{(\tau_t + \theta_t)^2}. \end{aligned}$$

Optimizing the government's objective for τ_t we get:

$$-1 + \frac{\theta_t \psi_t}{(\tau_t + \theta_t)^2} + Z_t \left(\tau_t - \frac{\tau_t}{\tau_t + \theta_t} \right)^{\frac{\alpha+\gamma-1}{1-\gamma}} \left(1 - \frac{\theta_t}{(\tau_t + \theta_t)^2} \right) = 0. \quad (19)$$

Here

$$Z_t = \frac{\alpha}{1-\gamma} \left(\frac{1}{l_{t+1} v_{t+1}} \right)^{\frac{\alpha}{1-\gamma}} \left(\beta E(A_{t+1}) \varphi_{t+1}^\gamma + \beta \varphi_{t+1} (1-\delta) - \varphi_{t+1} l_{t+1} v_{t+1} \right).$$

In this setup the government's objective function is strictly increasing in θ_t . However, there are constraints for increasing the fine rate. The situation can be modelled in the following way.

Small fines are cheap to pay for the company and create little corruption opportunities for tax officer. However, with the fine rate rising, tax officer's incentives to take a bribe go up. We assume that tax officer takes a bribe and gets fired without any compensation for the government or further punishment for the tax officer. The firm is willing to pay the bribe of the amount up to its due payments when it gets caught. The tax officer knows that they will be fired in case of the bribe and cannot find further work. Time horizon of the officer is assumed to be 30 years. It is further assumed that the officer's annual salary growth is equal to the reverse of their time preference discount factor. Mathematically the setup looks in the following way:

$$\sum_{t=0}^{30} S_t = (1 - w^r) (\tau_t + \theta_t) W_t L_t. \quad (20)$$

Here S_t is tax officer's net yearly salary. In the equation (11) above,

$$W_t L_t = \frac{W_t^r L_t}{w_t^r}.$$

Also, taking advantage of the condition derived above,

$$w_t^r = 1 - \frac{\psi_t}{(\tau_t + \theta_t) \exp(0.5\sigma_t^2)},$$

we get the following condition:

$$\theta_t = \frac{\left(\sum_{t=0}^{30} S_t \right) \frac{\psi_t}{W_t^r L_t}}{\left(\sum_{t=0}^{30} S_t \right) \frac{\exp(0.5\sigma_t^2)}{W_t^r L_t} - \psi_t} - \tau_t. \quad (21)$$

Considering the data from the sample at hand we get the average wage find of UAH 67,939 in the private sector in 2004 for the average number of employees of $L_t^r = 13.87$. That would correspond to the average wage of UAH 408.18, or, in the net terms, UAH $W_t^r = 351.58$. This corresponds to the average annual wage bill of UAH $W_t^r L_t^r = 13.87 \times 351.58 \times 12 = 58,517$ of reported net wage per firm. We approximate tax officer's salary S_t to be the average public officer's salary, found in the official statistics for 2004 to be UAH 690.98, corresponding to the net income of UAH 580.11 a month. Averaging their age to be 40 years and life expectancy to be 30 years (18 years before the retirement and 12 — after with pension provision equal to wage), in UAH terms,

$$\sum_{t=0}^{30} S_t = 580.11 \times 12 = 215,800.$$

Placing the data into the equation (12) we get the following condition:

$$\theta_t + \tau_t = \frac{3.69\psi_t}{3.69 \exp(0.5\sigma_t^2) - \psi_t}. \quad (22)$$

This puts the equilibrium constraint of $\theta_\infty + \tau_\infty = 2.58$ at $\psi = 1.52$.

5.3. Calibrating the model

As a discounting factor, we take the interest rate at which the government can borrow abroad, which is 7% yearly. This corresponds to $\beta = 0.935$. The depreciation rate δ is adopted from Beloded (2005) to be $\delta = 0.085$.

To evaluate the coefficients of α and γ , and find A_t , the equation was estimated

$$\log(y_t) = \log(A_0) + \log(a)t + \alpha \log(p_t) + \gamma \log(k_t).$$

Here y_t is the GDP per unit of labour, p_t is budget expenditures less social expenses, and k_t is the capital stock in the economy. Then $y_t = A_t p^a k^\gamma$, where $A_t = A_{t-1}a + \varsigma_t$.

For that purpose we estimated the model of the available monthly data for 1996–2001 of the following specification:

$$\begin{cases} \log\left(\frac{Y}{WL}\right) = C_1 + C_2 \times t + C_3 \log\left(\frac{K}{WL}\right) + C_4 \log\left(\frac{P}{WL}\right), \\ I = C_5 + C_6 R + C_7 Y, \\ K_t = K_{t-1} \left(1 - \frac{\delta}{12}\right) PPI_{t-1} + I_{t-1}. \end{cases}$$

Here I is investments, R is average borrowing rate in the economy, PPI is producer price index, WL is the wage bill in the economy. Initial value for capital was taken from the National Bank's data series. The series of capital stock was constructed on the basis of $\delta = 0.085$. Variables in the model appear in nominal terms.

This specification allowed calculating:

$$\alpha = C_4 = 0.22, \gamma = C_3 = 0.46, a = \exp(12C_2) = 1.002, A_0 = \exp(C_1) = 0.304.$$

For estimation, however, we assume $a = 0$ with zero variance.

For $l_t v_t$ we take geometric average of 1998–2004 growth of wage fund index in the economy. To correct for the lessening shadow sector, we divided each figure by the shadow sector contraction index. In the result, the growth of the wage bill is still high of $l_0 v_0 = 1.22$. This is assumed to be the starting value of the parameter with its further approaching the economy's long-run growth rate assumed to be 5%.

Concerning parameters determining the tax officer's behaviour, and, correspondingly, the firm's response, they are estimated taking considering the results of the short-run model. For the data series of $\{W^r, w^r\}$ and calculating for them $\{W, \tau\}$, we can calculate

$$\exp(0.5\sigma^2) = \frac{\psi}{(\tau + \theta)(1 - w^r)}.$$

Here $\theta_{2003} = 0.626$, and setting $\psi = 1.52$ we get the average of the variance series of $\sigma^2 = 0.54$.

Assuming the learning process to be $\sigma_{t+1}^2 = 0.95\sigma_t^2$, we get $\sigma_t^2 = 0.95^t \sigma_0^2$, where $\sigma_0^2 = 0.54$.

5.4. Evaluation

Now, putting the calibrated coefficients into the equation (10) we get a non-linear equation with one unknown, which is possible to solve numerically for $\{\tau_t\}$, from which it is possible to get all remaining required variables of $\{\theta_t\}$, $\{w_t^r\}$, $\{c_t\}$, $\{y_t\}$, $\{k_t\}$, and $\{p_t\}$.

The results of evaluation are represented in the figures below. Here the equilibrium taxation rate is equal to 0.730 (result after the 100th iteration) on top of the net wage, which is very close to the actual rate. Fine, however, goes to 1.85, which is about three times the current rate.

In the equilibrium, the reported wage share tends to 0.41 of the total net wage paid and the probability of being caught (audit effort) is 28.2%.

The lines are dashed in the figures due to specifics of the solution algorithm in Matlab adapted (see Figs 11–13).

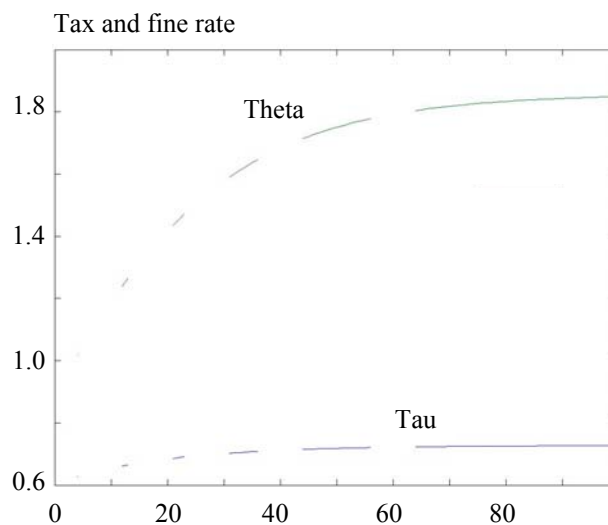


Fig. 10. Equilibrium path of tax and fine rates and reported share of wage

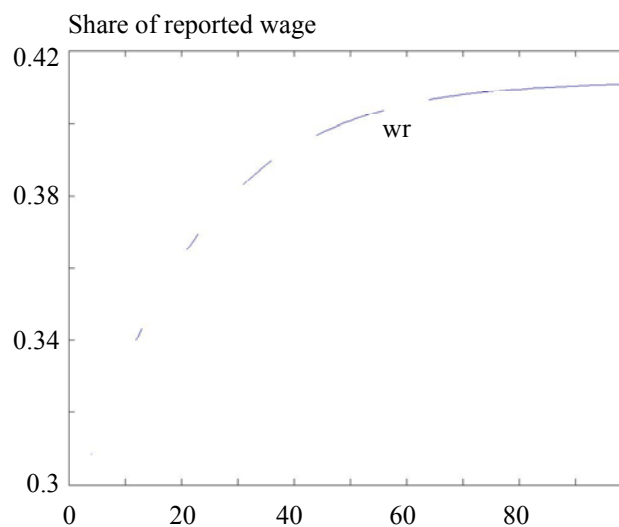


Fig. 11. Equilibrium path of tax and fine rates and reported share of wage

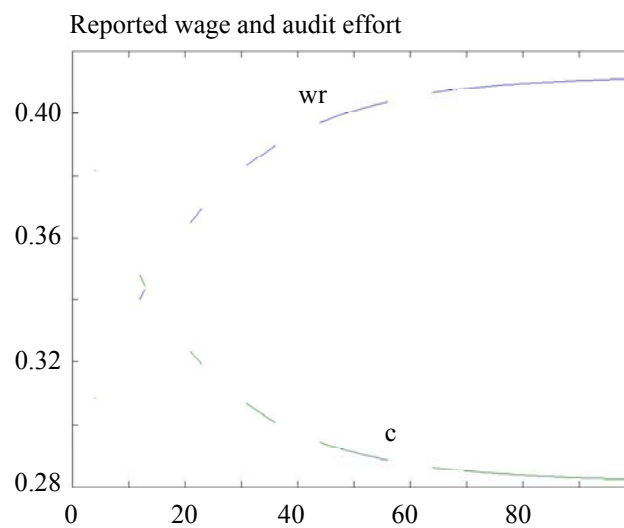


Fig. 12. Share of reported wage and probability of being caught equilibrium path

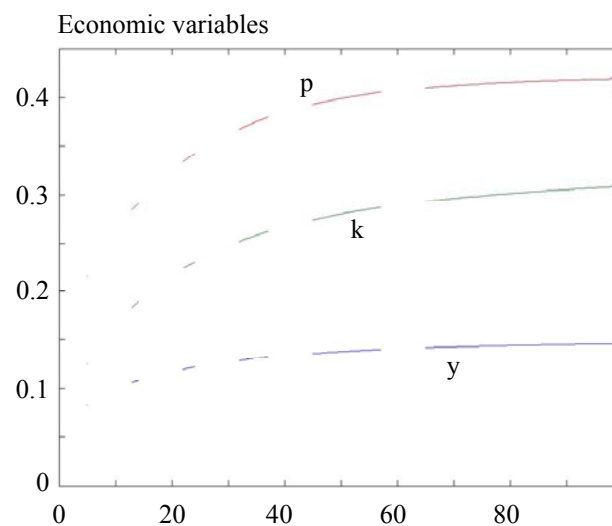


Fig. 13. Economic development variables equilibrium path

The results obtained enable the conclusion that within the framework of existing structural ties in the economy it is possible to increase compliance by introducing a more severe punishment for evasion. This is expected to be beneficial both for budget revenues and general economic development of the country. The existing tax rate is close to optimal and under the present conditions no other rate is expected to bring better results, taking into consideration the assumptions on the government's objective function.

Further improvements to the system might be developed by introducing structural changes into the economy which would break the assumptions laid into the basis of the model.

6. ECONOMETRIC SPECIFICATION AND ESTIMATION

6.1. Testing the first hypothesis

Testing the hypotheses econometrically, we apply the same assumptions made in simulating the numerical model, namely:

1. The model is that firms operate both in the regular economy, as well, as in the shadow. Some of the employees are employed officially, and some of them are hidden labour.
2. Employers are the only party responsible for paying labour taxes. Thus, firms' labour expenditures per one labour unit consist of wage rate including personal income tax and social taxes paid above wage rate.
3. The employee is interested in and bargains about only net wage they receive, which is assumed the only incentive for employment.

These assumptions predetermine strictly dominating demand labour channel of tax system mechanism. Quantitative analysis is applied to find out the cause-consequence relationship between tax rate and tax base of PIT.

As we already stated in the numerical model, firms operate both in the regular economy as well as in the shadow, thus the cut in the tax rate may cause de-shadowing of employees' income (at least for high figures of wage), which may actually result in: (i) increase in an official wage rate and correspondingly in the average official wage rate of an employee; (ii) increase in reported working hours (increase in total wage expenses); (iii) increase in both terms (no change in average wage rate but even more increase in wage fund); (iv) then, as underreporting wage is an attempt to decrease labour expenses, de-shadowing may also result in increasing labour/capital expenses ratio. In our analysis, we used change in average wage rate ($d_wage_av_i$), in total wage fund ($d_wag_fnd_i$), and in ratio of labour expenses to other expenses ($d_wage_ratio_i$) as endogenous variables in alternative econometric specifications. We took change in an average effective tax rate d_pit_i calculated for each firm, as a policy variable.

Also, it should be noted that the introducing flat low tax rate instead of the progressive high marginal tax rate might have several effects. As we cannot measure the share of underreported wage rate over the data sample, the problem is to distinguish between the tax change effect due to (i) the redistribution effect (labour became cheaper); (ii) and the de-shadowing effect. Thus, we make an assumption that the period under investigation is not long enough to make significant restructuring decisions but long enough to make decisions about tax reporting.

The typical problem with this econometric specification is endogeneity between wage and PIT rate. Policy experiment implies exogenous shift in effective PIT rate, but magnitude of change is determined by former level of PIT rate. To test this problem, we regressed d_pit on $d_wage_av_i$, $d_wag_fnd_i$, and $d_wage_ratio_i$. From the results of testing (see Appendices), we conclude there is no pronounced problem of endogeneity over the data sample, so we can apply OLS estimation method.

Endogeneity problem is a reason that's why we fail to estimate the model also for 2002–2003 data to compare results. Change in PIT rate for 2003 is completely determined by change in tax base, and the problem of endogeneity can be overcome only with specific instruments like simultaneous equations. Besides, it is not reasonable to estimate such a model for 2002–2003, since the PIT rate change in 2003 is not systematic factor of de-shadowing, as in 2004, where it is the result of policy experiment. In words, we cannot find out comparable results of de-shadowing for 2003 and 2004. Quoting Vasilieva *et al.* (2003), 'taking into account different macroeconomic environment, it is not important to compare effects before and after reform, it is important to compare effects with and without reform'.

It should be pointed out that there is a range of other factors, except PIT rate change, affecting wage, which was discussed in details by Vasilieva *et al.* (2003). Authors studied the PIT reform in Russia analysing different effects that the tax rate change may have on a change in wages, including redistribution of income and de-shadowing. In particular, they tested the effect of the tax rate change on wage de-shadowing considering firms' costs structure, which is the analogous approach applied in the research proposed. They outlined several external factors that may cause a change in wages, and then accomplished a simulation based on a production function of Cobb–Douglas to estimate a percentage contribution to an increase in wages of each considered factor, which may either strengthen or overweight any possible effect of the tax in the opposite direction. The factors outlined by Vasilieva *et al.* (2003) are the following:

- labour productivity increase;
- exogenous shift in labour demand;
- redistributions funds from other taxes changes;
- de-shadowing.

To this list we may add as well

- production scale increase.¹¹

Following Vasilieva's logics, we ignore first two factors. We accounted for a scale of production introducing a net revenues variable ($d_rev_net_i$) into the econometric specification. Also, we accounted for foreign capital participation introducing a dummy variable of FDI (fdi_yes), considering this factor as a stimulus for discipline and accuracy in documentation.

Testing the Hypothesis 1, we are interested in the sign and significance of the d_pit variable. According to the Hypothesis 1, we expect the coefficient to be negative and significant.

Thus, we presented three alternative econometric specifications, estimated data in the first differences of the sample of 1 200 firms for 2003–2004 period (see Appendix A6):

$$d_wage_av = 1.396 - 0.036 \times d_pit + 0.349 \times d_rev_net + 0.0012 \times d_tax_col + 0.139 \times fdi_yes; \quad (23)$$

s.e. (0.195) (0.115) (0.001) (0.293)

¹¹ Loayza (1997).

$$d_wage_fnd = -9.60 - 0.0048 \times d_pit + 0.004 \times d_rev_net + 0.261 \times d_exp_dif - 0.699 \times d_tax_col - 8.27 \times fdi_yes; \quad (24)$$

s.e. (0.007) (0.001) (0.005) (0.187) (39.17)

$$d_wage_ratio = -0.203 - 1.53 \times d_pit + 0.0006 \times d_rev_net - 0.155 \times fdi_yes. \quad (25)$$

s.e. (1.502) (0.0004) (0.379)

As we see, the sign is expectedly negative in all specifications, which implies negative impact of the tax rate on tax base evasion. However, the variable appeared significant only in the (23) specification, and only slightly and not very meaningful. This result allows us rather to reject Hypothesis 1 than to accept it. The de-shadowing effect is not pronounce for the whole sample of 1 200 firms. At most, PIT rate change provoked a little increase in official average wage rate, but failed to encourage some significant change in cost structure. This result follows the corresponding result obtained analytically from the theoretical model, where a cut in PIT rate provokes 1.7% increase in officially paid wage.

Redistribution effect of other taxes also appeared not significant, that is the opposite result obtained by Russian experts. It is not strange, as other taxes were not reformed so dramatically as in Russia. In particular, social taxes were not changed, which had the most important impact in Russia. Despite of our expectations, foreign capital participation is not somehow influential factor for wage change.

The literature on tax evasion argues that sensitivity of reported wages to a change in tax rates is determined by technology in a particular industry and may vary greatly among industries. Industries that considered as sensitive to a tax rate change on labour income are the following: (i) labour-intensive industries; (ii) industries with more productive less-skilled labour. Typically, these industries are services and agriculture. So, we re-estimated the most promising (23) specification with special dummies for industries, accounting for different the PIT rate change sensitivity across industries.

$$d_wage_av = 1.404 - 0.026 \times d_pit + 0.775 \times d_pit \times ind_ag - 0.550 \times d_pit \times ind_ind - 2.047 \times d_pit \times ind_trd -$$

s.e. (0.012) (1.960) (1.642) (1.331)

$$- 3.883 \times d_pit \times ind_srv - 1.642 \times d_pit \times ind_est + 0.003 \times d_rev_net + 0.0012 \times d_tax_col + 0.203 \times fdi_yes. \quad (26)$$

(1.656) (1.656) (0.001) (0.001) (0.303)

Indeed, results of testing demonstrates comparatively larger response to PIT rate change in service and trade industries, which are more labour-intensive. Meanwhile, there is no effect in the agriculture, where tax evasion is much easier in Ukraine.

Some authors also argue that the sensitivity of a response to tax rate change may vary even inside one industry depending on some other characteristics of firms. We define them as property forms, regions, and size of firms, and we accounted for these factors introducing corresponding dummies.

$$\begin{aligned}
d_wage_av = & 1.423 - 0.190 \times d_pit - 0.182 \times d_pit \times own_prv + 1.603 \times d_pit \times own_sta - \\
& s.e. \quad (0.093) \quad (0.227) \quad (1.841) \\
& - 0.219 \times d_pit \times own_col + 0.003 \times d_rev_net + 0.001 \times d_tax_col + 0.138 \times fdi_yes. \quad (27) \\
& (1.374) \quad (0.0001) \quad (0.001) \quad (0.304)
\end{aligned}$$

The PIT de-shadowing effect appeared significant for private firms and slightly significant for collective firms, however, still not very meaningful. It is a logic result, since tax evasion is spread among firms of other ownership than state.

$$\begin{aligned}
d_wage_av = & 1.401 - 0.617 \times d_pit + 1.523 \times d_pit \times reg_ct + 0.349 \times d_pit \times reg_es - 0.624 \times d_pit \times reg_st + \\
& s.e. \quad (0.384) \quad (1.539) \quad (1.385) \quad (1.612) \\
& + 3.765 \times d_pit \times reg_w + 0.349 \times d_rev_net + 0.0012 \times d_tax_col + 0.212 \times fdi_yes. \quad (28) \\
& (1.732) \quad (0.115) \quad (0.001) \quad (0.295)
\end{aligned}$$

Regions hardly determine sensitivity of a response to the PIT rate change.

$$\begin{aligned}
d_wage_av = & 1.414 - 0.020 \times d_pit - 2.553 \times d_pit \times siz_big + \\
& s.e. \quad (0.010) \quad (1.375) \\
& + 0.349 \times d_rev_net + 0.001 \times d_tax_col + 0.183 \times fdi_yes. \quad (29) \\
& (0.001) \quad (0.001) \quad (0.293)
\end{aligned}$$

The PIT de-shadowing effect appeared to be more pronouncing for big firms. At the first sight, it is quite surprising result, since tax evasion seems to be more important for small firms, which have larger part of labour expenses. However, with unchanged rate of social taxes, paying wages officially remains quite expensive for small firms; meanwhile, decreasing marginal PIT rate can be more significant for big firms, that traditionally hire high-skilled labour with relatively higher level of salary.

Although the de-shadowing effect of the PIT reform appeared to be rather weak, almost negligible, for the whole sample of firms, sensitivity of response to the PIT rate change varies across industries and forms of ownership. Thus, private firms and firms with labour-intensive technology, like services and trading, traditionally demonstrated a bit more increase in official average wages than others. Size of firm is also determining factor of response significance.

The estimation results, obtained for all specifications, appeared to be robust; but coefficients' values vary significantly across specifications. Thus, we are cautious to interpret numerical values and compare them with the corresponding ones, obtained analytically.

6.2. Testing the second hypothesis

To test the second hypothesis, we estimated cause-consequence relationships between the change in tax payments of firms for their employees (d_pit_col) and the average effective tax rate (d_pit). Fol-

The largest response of PIT collections is observed for big firms in comparison with small firms, despite of more pronouncing de-shadowing effect for big firms. Obviously, this de-shadowing effect is too small to compensate a sharp decrease in marginal tax rate for big firms.

6.3. Testing the third hypothesis

The third hypothesis implies that a cut in effective tax rate allows firms to decrease their labour expenses without changing either their tax obligations or employees' net wage rate. Having tested the first two hypotheses, we conclude that a cut in PIT rate hardly affected official wage rate paid and reported by an employer, and caused a fall in PIT collections. Thus, a part of government's income will be redistributed to employers, if a net wage rate received by an employee remains unchanged in response to decreased effective PIT rate. In the other case, if net wage rate will increase in a response to a cut in PIT rate, we have to reject the hypothesis and conclude that a loss in government income will be redistributed to both an employer and an employee.

$$d_net_wage_av = -0.65 - 9.034 \times d_pit + 0.732 \times d_wage_av + 0.067 \times fdi_yes - 0.00036 \times d_tax_col \quad (35)$$

s.e. (4.422) (0.007) (0.0743) (0.00033).

From the estimation output (Appendix A8), we conclude that after the PIT reform, PIT revenues were redistributed from the government to an employer, which allowed him to increase average net wage rate paid to his employee.

$$d_net_wage_av = -0.63 - 9.51 \times d_pit + 1.88 \times d_pit \times ind_ag + 0.61 \times d_pit \times ind_ind + 0.96 \times d_pit \times ind_trd +$$

s.e. (4.635) (0.493) (0.413) (0.335)

$$+ 1.20 \times d_pit \times ind_srv - 0.53 \times d_pit \times ind_est + 0.732 \times d_wage_av + 0.072 \times fdi_yes - 0.0004 \times d_tax_col; \quad (36)$$

(0.417) (0.416) (0.007) (0.076) (0.00033)

$$d_net_wage_av = -0.63 - 8.202 \times d_pit - 0.564 \times d_pit \times own_prv - 2.775 \times d_pit \times own_sta -$$

s.e. (4.355) (0.393) (0.462)

$$- 0.534 \times d_pit \times own_col + 0.732 \times d_wage_av + 0.096 \times fdi_yes - 0.00054 \times d_tax_col; \quad (37)$$

(0.345) (0.007) (0.0763) (0.00033)

$$d_net_wage_av = -0.64 - 7.478 \times d_pit + 1.741 \times d_pit \times reg_ct + 2.313 \times d_pit \times reg_es + 1.532 \times d_pit \times reg_st +$$

s.e. (3.721) (13.42) (3.365) (1.909)

$$+ 1.340 \times d_pit \times reg_w + 0.732 \times d_wage_av + 0.03 \times fdi_yes - 0.00039 \times d_tax_col; \quad (38)$$

(14.59) (0.007) (0.0737) (0.00033)

$$d_net_wage_av = -0.64 - 8.824 \times d_pit - 1.073 \times d_pit \times siz_big + 0.730 \times d_wage_av +$$

s.e. (4.376) (0.349) (0.007)

$$+ 0.086 \times fdi_yes - 0.00045 \times d_tax_col. \quad (39)$$

(0.0743) (0.00034)

After additional testing, distinguishing among different firms' characteristics, we conclude that the largest increase in net wages received by employees occurred in firms with the largest response of PIT payments to the reform. This result confirms the previous conclusion that, following the PIT reform, the government tax income was redistributed to firms, after which was partly transformed into employees' income.

7. CONCLUSIONS AND RECOMMENDATIONS

The 2003 PIT reform stipulated for abolishing many exemptions and privileged group of taxpayers and instituting the flat tax rate of 13%. The government expected quite significant personal income de-shadowing as a result of the reform, which should compensate for the PIT revenues fall due to the tax rate cut. Unfortunately, the PIT revenues fell in 2004 for the first time since 1993, and the share of PIT revenues in the total tax collections also went down. It became obvious that reducing PIT rate, even so significantly, is not a panacea for PIT evasion and may lead to financial instability in the short-run. So, to design effective PIT policy, the nature of PIT evasion should be studied more carefully. Besides, the tax reform that is a natural experiment that represents a theoretical interest and provides a good ground for researching the behavioural effects of the changes introduced.

In the framework of the research, we developed a methodology, relevant to personal-income tax response analysis in the Ukrainian context. The research approach adopted involves constructing theoretical general equilibrium model adapted to practices in the Ukrainian economy. Empirical testing of the hypotheses on the micro company data that follows revealed the reform effects and confirmed adequacy of the theoretical model and validity of the assumptions adapted.

Both analytical solution of the theoretical model and econometrician testing do not reveal any significant de-shadowing effect of the PIT reform. This means that the reform did not stimulate any tangible structural changes in the economy. However, according to empirical investigations, private firms and firms with labour-intensive technology, such as services and trading, demonstrated a bit higher increase in official wages in a response to the change in the PIT rate than others. Meanwhile, another labour-intensive industry, agriculture, remained indifferent to the reform. Further reforms of the taxation system, including payments to social security funds, which make the biggest share in the burden of taxes levied on wages, might generate a different picture. Still, the effect of the further lessening is not convincingly positive.

Further estimations confirm the second hypothesis that a decreased effective PIT rate provoked a considerable fall in PIT payments. The theoretical model showed that the PIT collections would have fallen by UAH 0.45 per employee per month in 2003 money if there had been no growth in the economy. Econometric estimation showed that in particular, this effect is larger for firms, which have no evidence for de-shadowing. However, big firms, in comparison with small firms, have more pronounced de-shadowing effect and simultaneously a larger fall in PIT payments. It follows, that lower marginal PIT rate can be more significant for big firms, which traditionally hire high-skilled labour with relatively higher level of wages. At the same time, the effective PIT rate became

much lower for them after the reform, so their PIT payments decreased at a bigger extent than small firms' payments.

As both theoretical modelling and econometrics revealed, the government's income in the form of PIT revenues was redistributed after the reform from the government to firms. Empirical part further showed that this income re-distribution allowed firms to pay higher net wages to their employees. Those firms, which have more considerable reduction in their PIT payments, increased a net wage rate to a bigger extent.

These effects of the reform, formalized by the econometric estimation, logically follow the predictions of the theoretical model, where the weak result of the reform is predetermined by conditions of the dominating labour demand channel: (1) cost structure of firms with prevailing labour expenses; (2) the labour tax burden is mainly levied on employers; (3) all responsibility for tax reporting and paying is levied on firms (due to this, employees are often not familiar with the relevant legislation); (4) there is no direct benefit from paying taxes (like those in the three-pillar pension system); (5) and, therefore, employees are hardly involved in firms' decision making whether to report their wages, in particular, in industries with relatively effective low-skilled labour. Thus, employers' decisions are strictly bounded, while employees' role is minimized. In such conditions, without grounded structural reforms, the PIT reform of the current design failed to produce any significant positive shift in the firms' incentive system, especially considering that the PIT constitutes a minor share of total labour expenses.

The results we obtained from the analytical model enable us to make the conclusion that within the framework of existing structural ties in the economy it is possible to increase compliance by introducing a more severe punishment for evasion. This is expected to be beneficial both for budget revenues and general economic development of the country. The existing tax rate is close to optimal and under the present conditions no other rate is expected to bring better results, taking into consideration the assumptions on the government's objective function.

Under the results of the study the expected punishment and the low perceived probability of being caught evading are too low, which stipulates for the low observed tax compliance. The findings of the model show that audit efforts must be intensified by about 3-fold.

Further improvements to the system might be developed by introducing structural changes into the economy which would break the assumptions laid into the basis of the study. Particularly:

1. further reforming the PIT system (sharing tax reporting responsibility by both the employer and the employee);
2. reforming the social security system (a single social tax rate and more tax burden on employees);
3. reforming the pension system (introducing three-pillar system);
4. reforming the financial market (with perspectives of individuals' private capital placement);
5. more intensive labour policy for labour markets with relatively low labour skills.

Also, reforming tax system should include single social tax at a lower rate and transforming a part of the tax burden from the employer to the employee. But this makes sense if the pension and social security reforms are introduced; and reforming regulations in the labour market will allow decreasing unemployment costs and increasing the influence of employees in contract negotiating with employers. Still, even introducing a single social tax of a lower rate, will be insufficient to encourage employers opt in favour of official jobs and wages without appropriate level of tax compliance enforcement.

Other factors able to create incentives for firms to bring their employees' income out of the shadow are believed to be a lower level of corruption, a higher quality of public services and direct benefits from paying taxes (a close connection between social payments and social benefits). Generally, the importance is emphasised on further improving the tax system's transparency and simplicity, and appropriate compliance enforcement. Another important factor is developing institutional settings.

APPENDICES

A1. The history of tax reform in Ukraine

Actually, the history of the activities on de-shadowing and tax reform, in particular, as a rather entangled one. The tax code, which passed its first reading in Parliament in July 2000 and its second in December 2001, at the end of 2002 still had many drawbacks, especially concerning taxation of small businesses and the administration of taxes. Still, the code stipulated cutting the value added tax from 20 percent to 17 percent and the profit tax from 30 percent to 25 percent. It also reduced the number of taxes, especially redundant local taxes. Autumn 2002 discussions pointed directions of its future improving. Final adoption of the code was then predicted to take place after the 2002 parliamentary elections.

So the talks on the new Tax Code (though there is no "old" one, and the legislation on taxation is a tricky mix of numerous legal acts and sub-acts, and explanations how to understand some norms) were conducted yet in late ninety's, but the legislative process on this issue was endlessly dragging on.

Still, by now, the process of reforming the tax system has seen a great progress. It got its real start early in the year 2003 when the Verkhovna Rada of Ukraine adopted laws on lowering tax rates. According to them starting from 2004 personal income tax saw radical changes: instead of the progressive scale acting in the economy before there was a proportional system with the common rate of 13 percent introduced. Since 2007 the rate was adopted to be 15 percent and 5 percent will be withdrawn from deposit interest revenues.

So, the question of affecting the shadow sector has been raised for long. Among the relevant actions of governmental policy the ones dominated which stipulated for decrease in the tax rates and toughening tax administering. The most important actions of the government have been the following:

1. Tax cuts introduced:

- In 1995 the upper margin of the PIT rate was reduced from 50 to 40% and the minimum income subject to it increased from 25 untaxed minimums to 100 ones;
- In 1997–1999 additional payments for the wage fund to the social funds were gradually reduced from 52 to nearly 40%;
- In 1999 the simplified system of taxing small businesses was introduced. The system allows for replacing several taxes and social funds subtractions by a single tax;
- From 2004 the PIT rate is ad valorem of 13% to replace the previous progressive (0–40%, Figs 1–3) system. Corporate profit tax was also lowered to 25 percent since the start of 2004 down from 30 percent collected before. The PIT change mentioned was the most radical one. This made the tax burden significantly smaller especially for the wages exceeding the average one.

2. Program of de-shadowing adopted in 2001. It allows, among other things for reforming the system of lax privileges, deregulating businesses' activities, regulating the financial system and activities of governmental agencies, and intensification of monitoring enterprises' activities. A number of key decisions in execution of the program have not been implemented.
3. In 1996–2003, a number of laws were adopted on development of the financial system of Ukraine.
4. In July 2003, the Law on Mandatory Pension Insurance adopted.
5. In July 2003, the Law on Mandatory Medical Insurance adopted in the second reading.
6. In 2003, all anonymous accounts in banks closed.
7. From January 1, 2007 the tax on deposits interests is going to be introduced of 5%.

The essence of the 2004 tax reform is presented in the table below.

2003 system		2004 system	
<i>Total Labor Expenses</i>		<i>Total Labor Expenses</i>	
+Unemployment fund	1.9%	+Unemployment fund	1.9%
+Social Insurance	2.9%	+Social Insurance	2.9%
+Pension fund	32%	+Pension fund	32%
<i>Gross wage</i>		<i>Gross wage</i>	
–Pension Fund	1–2%	–Pension Fund	1–2%
–Employment Fund	0.5–1%	–Employment Fund	0.5–1%
–Unemployment Fund	0.5%	–Unemployment Fund	0.5%
–PIT	0–40%	–Tax Privilege	
<i>Net wage</i>		<i>PIT Base</i>	
		–PIT	13%
		+Tax Privilege	
		<i>Net wage</i>	

Tax on the wage fund did not change and made 36.8% in both years. In 2004 the thresholds for calculating different Pension and Employment Fund Subtractions changed. Also a completely new notion of the PIT base was introduced equal to Gross wage minus subtractions to social funds.

The real tax load on net wage received by the employee was shown in Fig. 1.

A2. Data sampling

The criteria of representativity chosen were those of industry, region, and the form of ownership. The figures were calculated on the SSC report for the beginning of 2003 about the total number of the companies (registered) under the assumption of the proportion of really active companies to the total amount across all of the criteria listed in Appendix A2.

1. Industry. Different industries may differ in their reported wage rates. The arbitrage does not arise because of the rigidity of labour (especially qualified one) to shift among industries, and, also, possibly, the reported wage makes different part of the total wage received by employees across different industries.

Industry	Population data	Proportion	Sample data
Agriculture, hunting and forestry; fishing	80155	9.6%	117
Processing, extracting industries, utilities and energy production and distribution	103267	12.5%	150
Wholesale and retail trade, trade of transport means; repairing services	246375	29.8%	358
Real estate operations, lessor activities, and services for legal entities	88703	10.7%	129
Collective, public, and personal services	106832	12.9%	155
Others (each less than 7%), including: Construction; Hotel and catering business; Transport and communication; Financial activities; Public administration; Education; Healthcare and social welfare	200546	24.5%	291
Totally	825878	100%	1200

2. Region. Different regions of Ukraine represent different specialisations in terms of inherited business culture, natural resources available, industrial development, investment activity there, etc. According to the Ukrainian Constitution, its territory consists of 24 oblasts, one autonomous republic of the Crimea, and the cities of Kyiv and Sevastopol. Still, considering all 27 regions in the work is not expedient, so on the criteria of similarities of culture, resources, industrial development, financial flows intensity, there were 5 regions selected conventionally, each having its peculiarities:

Region	Population data	Proportion	Sample data
<i>South:</i> Autonomous Republic Crimea, Mykolaiv, Odesa, Kherson, the city of Sevastopol	160867	17.2%	206
<i>Centre:</i> Vinnytsia, Zhytomyr, Kyiv, Kirovohrad, Poltava, Khmelnytskyi, Cherkasy, Chernivtsi, Chernihiv	190974	20.4%	245
<i>West:</i> Volyn, Zakarpattia, Ivano-Frankivsk, Lviv, Rivne, Ternopil	134515	14.4%	173
<i>East:</i> Dnipropetrovsk, Donetsk, Zaporizhia, Luhansk, Kharkiv, Sumy	302033	32.3%	387
The city of Kyiv	147189	15.7%	189
Totally	935578	100%	1200

3. The form of ownership. State and communal (actually, local authorities) property is managed in similar way. Still, they are of representative share each. Collective ownership includes, among others the ownership of joint stock companies, limited liability societies and other companies (eco-

economic societies — under the Ukrainian law). For calculations here ownership by foreign legal entities is disregarded.

Ownership of	Population data	Proportion	Sample data
State	66040	8.1%	97
Communal	132045	16.1%	193
Private	210266	25.7%	308
Collective (ownership of economic societies, cooperatives, <i>etc</i>)	410976	50.2%	602
Totally	819327	100%	1200

4. Size. Also considered was the size of the companies. Ukrainian legislation distinguishes between small and large companies. The former are those not exceeding 50 people in the number of employees, and Euro 500 thousand in their turnover. They have the right to enjoy simplified taxation. Small companies are believed to engage more in tax evasion activities. So big companies (making a representative number in the sample) can be regarded as a control group.

Size	Population data	Proportion	Sample data
Small companies	218500	88.3%	1059
Big companies	28913	11.7%	141
Totally	247413	100%	1200

5. Participation of foreign capital. Companies, enjoying foreign direct investments, are believed to bear foreign culture (it can be a strong assumption for western investments) and so engage in the evasion activities to a negligible extent. As far as the total number of companies with FDI does not make any representative share, their number taken for the sample is the minimum representative of 100.

FDI availability	Population data	Proportion	Sample data
Companies with FDI		8.3%	100
Purely domestic companies		91.7%	1100
Totally		100%	1200

A3. Creating data series

The data obtained enable creating the following data series:

Selection dummies

1. Industrial dummies:

- a. *IND_AGR*: dummy for 'Agriculture, hunting and forestry; fishing': 117 companies;
- b. *IND_IND*: dummy for 'Processing, extracting industries, utilities and energy production and distribution': 150 companies;

- c. *IND_TRD*: dummy for 'Wholesale and retail trade, trade of transport means; repairing services': 358 companies;
- d. *IND_EST*: dummy for 'Real estate operations, lessor activities, and services for legal entities': 129 companies;
- e. *IND_SRV*: dummy for 'Collective, public, and personal services: 155 companies;
- f. *IND_OTH*: dummy for Others (each less than 7%), including: 'Construction; Hotel and catering business; Transport and communication; Financial activities; Public administration; Education; Healthcare and social welfare': 291 companies.

Equivalences:

$$IND_AGR + IND_IND + IND_TRD + IND_EST + IND_SRV + IND_OTH = 1200.$$

2. Regional dummies:

- a. *REG_STH*: dummy for South (Autonomous Republic Crimea, Mykolaiv, Odesa, Kherson, the city of Sevastopol regions) : 206 companies;
- b. *REG_CTR*: dummy for Centre (Vinnytsia, Zhytomyr, Kyiv, Kirovohrad, Poltava, Khmelnytskyi, Cherkasy, Chernivtsi, Chernihiv regions) : 245 companies;
- c. *REG_WST*: dummy for West (Volyn, Zakarpattia, Ivano-Frankivsk, Lviv, Rivne, Ternopil) : 173 companies;
- d. *REG_EST*: dummy for East (Dnipropetrovsk, Donetsk, Zaporizhia, Luhansk, Kharkiv, Sumy regions) : 387 companies;
- e. *REG_KYV*: dummy for the city of Kyiv: 189 companies.

Equivalences:

$$REG_STH + REG_CTR + REG_WST + REG_EST + REG_KYV = 1200.$$

3. Form of ownership dummies:

- a. *OWN_STA*: dummy for State ownership: 97 companies;
- b. *OWN_COM*: dummy for Communal ownership: 193 companies;
- c. *OWN_PRV*: dummy for Private ownership: 308 companies;
- d. *OWN_COL*: dummy for Collective ownership: 602 companies.

Equivalences:

$$OWN_STA + OWN_COM + OWN_PRV + OWN_COL = 1200.$$

4. Size dummies:

- a. *SIZ_SML*: dummy for Small companies: 1044 companies;
- b. *SIZ_BIG*: dummy for Big companies: 156 companies.

Equivalences:

$$SIZ_SML + SIZ_BIG = 1200.$$

NB: some of the companies changed their status from large to big or vice versa in these 3 years. The data was compiled for the criteria of representativity corresponding to 2003. Notably, the number of small companies increased. That means that more companies chose reporting in the simplified way as regulated for small companies, as shown in the table below.

Table 2. Dynamics of the sample companies size status

2002		2003		2004	
Big companies	Small companies	Big companies	Small companies	Big companies	Small companies
174	1026	156	1044	139	1061

Concerning size, the inconsistency of the data is that different reporting forms specify different status (the difference is observed, in particular, between the Entrepreneurship form and Income statement form. Balance notion of size is identical to that in the income statement). The size dummy defined corresponded to the reporting in the Income statement.

5. Participation of foreign capital dummies:

- a. *FDI_NOO*: Purely domestic companies: 1100 companies;
- b. *FDI_YES*: Companies with *FDI*: 100 companies.

Equivalences:

$$FDI_NOO + FDI_YES = 1200.$$

Totally, there are 19 dummy variables, of which 5 are not independent. There are also 3 dummies for years (1 not independent).

Income statement variables

6. Revenues data:

- a. *REV_GROS*: gross revenues;
- b. *TAX_IND*: indirect taxes and other income related payments (for small companies) or come of value added tax, excise (for domestic and imported products) and other subtractions from revenue (for big companies);
- c. *PRF_GRS*: gross profit (equal gross revenues minus indirect taxes and other subtractions from revenue).

Equivalences:

$$REV_GROS - TAX_IND = PRF_GRS.$$

7. *PRF_OPR*: operational profit (equal to gross profit plus other operational income minus operational expenses).

8. *PRF_FIN*: financial profit (from all normal activity of the company).

9. Income data:

a. *INC_GRS*: gross income (equal to financial profit plus profit from extraordinary activities);

b. *TAX_CPT*: corporate profit tax (imposed on gross income);

c. *INC_NET*: net income (gross income minus corporate profit tax).

Equivalences:

$$INC_GRS - TAX_CPT = INC_NET.$$

10. Elements of operational expenses:

a. *EXP_MAT*: Material expenses;

b. *EXP_LAB*: Expenses for labour (all expenses for labour equal to wage fund plus extra payments over wage fund);

c. *EXP_SOC*: Social expenses;

d. *EXP_DEP*: Depreciation;

e. *EXP_OTH*: Other operational expenses.

Totally, there are 13 variables obtained from income statement of companies, out of which 11 are independent.

Balance sheet variables

11. Fixed assets:

a. *INV_LON*: long term financial investments at the end of period;

b. *DINV_LON*: change of long term financial investments in the period;

c. *AST_FIX*: fixed assets at the end of period;

d. *DAST_FIX*: change of fixed assets in the period.

12. Working capital:

a. *RES_BUD*: receivables related to budget payments;

b. *DRES_BUD*: change of receivables related to budget payments in the period;

c. *ACT_RES*: accounts receivable totally at the end of period;

d. *DACT_RES*: change of total accounts receivable in the period.

13. Deferred costs:

a. *DEF_COS*: deferred costs at the end of period;

b. *DDEF_COS*: change of deferred costs in the period.

14. Balance:
 - a. *BAL_TOT*: total balance at the end of period;
 - b. *DBAL_TOT*: change of total balance in the period.
15. Shareholders equity:
 - a. *CAP_STT*: statutory capital at the end of period;
 - b. *DCAP_STT*: change of statutory capital in the period;
 - c. *SHH_EQU*: shareholders equity at the end of period;
 - d. *DCAP_STT*: change of shareholders equity in the period.
16. Reserve for deferred costs and payments:
 - a. *DEF_RES*: reserve for deferred costs and payments at the end of period;
 - b. *DDEF_RES*: change of reserve for deferred costs and payments in the period.
17. Long term liabilities:
 - a. *LOA_LON*: long-term bank loans at the end of period (long-term loans are available only for big companies);
 - b. *LOA_LON*: change of long-term bank loans in the period (long-term loans are available only for big companies);
 - c. *LIA_LON*: long-term liabilities at the end of period;
 - d. *DLIA_LON*: change of long-term liabilities in the period.
18. Current liabilities:
 - a. *LOA_SHR*: short-term bank loans at the end of period;
 - b. *LOA_SHR*: change of short-term bank loans in the period;
 - c. *LIA_SHR*: short-term liabilities at the end of period;
 - d. *DLIA_SHR*: change of short-term liabilities in the period.
19. Deferred revenues:
 - a. *DEF_COS*: deferred revenues at the end of period;
 - b. *DDEF_COS*: change of deferred revenues in the period.

Totally, there are 28 variables obtained from the balance sheet form. All of them are independent. Values for the start of the period can be obtained from values for the end of the period minus change of the figure in the period.

Entrepreneurship form variables

20. *PRD_TOT*: total amount of goods and services produced in the current prices (without VAT and excise).

21. *EXP_PRD*: expenses for production of goods and services (reference series, not all companies filled the values in the reporting form).

22. *TAX_COL*: taxes, collections, obligatory payments (reference series, not all companies filled the values in the reporting form).

23. Labour data:

- a. *EMP_STF*: annual average number of staff employees, people;
- b. *EMP_FRL*: annual average number free-lance employees (working on the contract basis or external employees combining jobs), people;
- c. *EMP_UNP*: number of unpaid workers (owners, founders, and their family members), people;
- d. *EMP_HRS*: worked by staff employees, person-hours;
- e. *EMP_PRT*: part-time workers (of staff).

24. Wage data:

- a. *WAG_FND*: wage fund total;
- b. *WAG_FRL*: of wage fund for free-lances (counted by *EMP_FRL*);
- c. *WAG_OTH*: of wage fund for employees, who worked at other companies during the year.

25. Investments data:

- a. *INV_DUM*: dummy for investments into fixed capital during the period;
- b. *INV_FIX*: total investments into fixed capital;
- c. *INV_MAT*: total investments into material assets;
- d. *INV_NMT*: total investments into non-material fixed capital.

Equivalences:

$$INV_FIX = INV_MAT + INV_NMT ;$$

$$INV_DUM = \text{sign} (INV_FIX) .$$

26. *FDI_INF*: dummy showing whether foreign direct investments were obtained by the company by the moment of the end of the year.

Totally, there are 16 variables obtained from the entrepreneurship form, out of which 2 are dummies, 2 are dependent, and 2 are reference series (available for a sub-sample of companies).

In the total, the data are described as the following:

Table 3. Types of data series available

	Dummies	Of them selection dummies	Other variables
Totally	21	19	55
Of them independent	15	14	52

A4. Data description and analysis

Descriptive statistics for the data look in the following way.

Table 4. The descriptive statistics of the micro data

	Non-Zero observations	Minimum value	Maximum value	Kurtosis	Median	Skewness	Mean	Standard deviation	0.15 percentile	0.85 percentile
<i>IND_AGR</i>	351	0	1							
<i>IND_IND</i>	450	0	1							
<i>IND_TRD</i>	1074	0	1							
<i>IND_EST</i>	387	0	1							
<i>IND_SRV</i>	465	0	1							
<i>IND_OTH</i>	873	0	1							
<i>REG_STH</i>	618	0	1							
<i>REG_CTR</i>	735	0	1							
<i>REG_WST</i>	519	0	1							
<i>REG_EST</i>	1161	0	1							
<i>REG_KYV</i>	567	0	1							
<i>OWN_STA</i>	291	0	1							
<i>OWN_COM</i>	579	0	1							
<i>OWN_PRV</i>	924	0	1							
<i>OWN_COL</i>	1806	0	1							
<i>FDI_NOO</i>	3300	0	1							
<i>FDI_YES</i>	300	0	1							
<i>SIZ_SML</i>	3131	0	1							
<i>SIZ_BIG</i>	469	0	1							
<i>REV_GROS</i>	3564	0	213347	370.60	166.6	15.57	1437.50	6602.96	18.585	1526.20
<i>TAX_IND</i>	2489	0	19901.6	211.73	14.15	12.35	199.40	865.28	0	229.09
<i>PRF_GRS</i>	3564	0	213347	511.48	145.7	18.06	1238.09	5937.77	17.1	1299.8
<i>PRF_OPR</i>	3489	-11836.2	212211.9	1586.30	5.8	35.01	412.39	4360.18	-19.43	289.81
<i>PRF_FIN</i>	3473	-13382	212191.5	1601.16	5.6	35.18	406.72	4348.64	-17.53	280.105
<i>INC_GRS</i>	3446	-13382	12585.7	236.67	0.7	-3.11	-6.29	611.45	-25.615	35
<i>TAX_CPT</i>	1305	0	6061.6	756.20	0	25.53	15.63	173.83	0	5.5
<i>INC_NET</i>	3420	-13382	9446.5	267.66	0.3	-10.02	-21.92	554.33	-27.415	26.83
<i>EXP_MAT</i>	2717	0	43845.6	243.65	8.4	13.69	309.85	1745.58	0	207.205
<i>EXP_LAB</i>	3520	0	26323.9	538.96	19.55	18.86	128.30	722.28	4.085	99.16
<i>EXP_SOC</i>	3219	0	9729.3	509.47	3	18.72	39.82	273.64	0.2	22.915

	Non-Zero observations	Minimum value	Maximum value	Kurtosis	Median	Skewness	Mean	Standard deviation	0.15 percentile	0.85 percentile
<i>EXP_DEP</i>	2671	0	7526.9	226.18	2.2	14.02	54.97	363.70	0	32.83
<i>EXP_OTH</i>	3397	0	46465.7	649.26	18.7	22.48	193.85	1278.20	1.9	169.5
<i>INV_LON</i>	225	0	35998.1	874.72	0	28.34	58.67	1061.17	0	0
<i>DINV_LON</i>	103	-2383.5	30147.7	2869.86	0	51.51	11.93	532.37	0	0
<i>AST_FIX</i>	3136	0	133126	251.73	24.2	14.37	1039.72	6325.24	0.3	539.515
<i>DAST_FIX</i>	2944	-23144	89429.7	1410.64	0	31.83	65.16	1912.01	-15.7	23.745
<i>RES_BUD</i>	1813	0	6995.1	989.39	0.1	28.05	18.96	169.68	0	9
<i>DRES_BUD</i>	2029	-1322.5	2330.7	239.23	0	8.31	2.63	88.61	-1.5	1.6
<i>ACT_RES</i>	3518	0	67350.4	273.63	46.1	14.75	553.31	2721.95	3.4	533.095
<i>DACT_RES</i>	3488	-8139.1	50993.3	1174.88	0.9	28.02	74.21	1131.22	-28.215	70.845
<i>DEF_COS</i>	997	0	1423.4	445.29	0	18.71	5.18	46.99	0	1
<i>DDEF_COS</i>	1006	-2366.5	1417.3	911.88	0	-13.31	0.90	58.64	0	0.1
<i>BAL_TOT</i>	3551	0	137305	156.93	111.55	11.30	1598.21	7714.21	10.285	1288.93
<i>DBAL_TOT</i>	3525	-23069	91395.1	813.35	1	23.62	140.27	2294.86	-43.515	117.73
<i>CAP_STT</i>	2840	0	148635	471.81	10	19.74	703.67	5523.25	0	258.8
<i>DCAP_STT</i>	588	-5554.8	10000	286.48	0	9.25	14.29	363.98	0	0
<i>SHH_EQU</i>	3489	-11829	134334	266.03	31.65	14.85	957.84	6131.47	-2.015	537.405
<i>DCAP_STT</i>	3400	-23880	84162.4	1496.83	0	32.01	25.25	1774.55	-33.915	42.715
<i>DEF_RES</i>	296	0	7917.6	952.84	0	26.91	14.98	188.54	0	0
<i>DDEF_RES</i>	286	-2787	4471.1	757.40	0	15.39	2.11	122.32	0	0
<i>LOA_LON</i>	32	0	18917.6	1842.12	0	40.25	13.71	378.09	0	0
<i>LOA_LON</i>	37	-2384	10963	1580.20	0	37.46	7.08	238.79	0	0
<i>LIA_LON</i>	378	0	23265.2	541.59	0	20.07	70.59	662.52	0	0
<i>DLIA_LON</i>	366	-3246	15310.6	867.90	0	24.96	10.54	388.87	0	0
<i>LOA_SHR</i>	311	0	15855	1373.52	0	31.81	34.10	337.43	0	0
<i>LOA_SHR</i>	393	-3384.5	12673	1250.92	0	27.06	7.47	276.96	0	0
<i>LIA_SHR</i>	3438	0	69654.2	209.53	32.2	12.81	549.09	2911.33	2.1	422.645
<i>DLIA_SHR</i>	3455	-11480	50823.9	611.31	0.9	21.07	99.77	1497.46	-23	70.315
<i>DEF_COS</i>	103	0	6111.7	1732.98	0	38.58	5.71	124.07	0	0
<i>DDEF_COS</i>	114	-286	6111.7	2804.15	0	51.23	2.60	108.77	0	0
<i>PRD_TOT</i>	3593	-473.6	97678.9	218.35	101	12.89	871.67	4115.36	13.485	819.345
<i>EXP_PRD</i>	3102	0	99215.5	1274.89	55.45	30.72	361.95	2159.67	1.6	377.54
<i>TAX_COL</i>	2714	0	1521.9	222.21	1.6	12.79	14.55	61.47	0	19.115
<i>EMP_STF</i>	3490	0	3940	489.47	6	17.66	24.87	110.36	2	25

	Non-Zero observations	Minimum value	Maximum value	Kurtosis	Median	Skewness	Mean	Standard deviation	0.15 percentile	0.85 percentile
<i>EMP_FRL</i>	1453	0	316	734.30	0	21.02	2.00	7.86	0	3
<i>EMP_UNP</i>	197	0	8	146.09	0	9.45	0.07	0.34	0	0
<i>EMP_HRS</i>	3489	0	6133926	449.83	10868.5	16.78	41541.04	175698.6	2022.8	42436.2
<i>EMP_PRT</i>	919	0	956	788.40	0	25.89	2.68	25.92	0	2
<i>WAG_FND</i>	3557	0	26323.9	505.52	19.8	18.34	129.05	736.14	4.185	100.73
<i>WAG_FRL</i>	1441	0	1184.4	841.91	0	22.79	5.86	28.43	0	6.7
<i>WAG_OTH</i>	98	0	48.4	368.44	0	17.45	0.16	1.73	0	0
<i>INV_DUM</i>	1141	0	1	-1.38	0	0.79	0.32	0.47	0	1
<i>INV_FIX</i>	1141	0	17866.1	459.32	0	19.16	74.90	611.40	0	25.215
<i>INV_MAT</i>	1116	0	17861.1	474.07	0	19.46	73.28	604.11	0	24.145
<i>INV_NMT</i>	139	0	2807	3307.79	0	56.57	1.30	47.78	0	0
<i>FDI_INF</i>	3600	1	2	24.34	2	-5.13	1.97	0.18	2	2

Data analysis

Investigating the sample for outliers produces the following results.

1. For the company 573 a dummy is needed. It is the ultimate outlier in many series (too big figures) and it is a small company, and its revenues go from 200 million in 2003 to zero in 2004.
2. Company 929 might also need a dummy as in 2003 it paid CIT more than its income was and had great losses because of that.
3. Company 322 paid 26 million in labour expenses (ultimate outlier) and had losses of 11 million in 2004 because of that. In 2002–2003 it paid 706 and 756 thousand in labour expenses. In 2003 it also had social expenses of 9.7 million and other similar figures (depreciation of 5.8 million against 98 thousand in 2003).
4. Company 323 is the major outlier in Long-term investment. They invested 30 million in 2002 but their revenues are really low (less than a1 million).
5. Companies 231, 251, 158 are outliers by the volume of fixed assets. 158 increased its fixed assets in 2004 by 89 million.
6. State debt to 110 is huge and rises in 2002–2004 from 3 to 70 million.
7. 429 had a huge change in accounts receivable of 51 million.
8. 231, 251, 229, 323, 151 and 158 are outliers by total balance and its change.
9. 158, 231, 251, 323, 557, 929, and 973 are outliers by the amount of statutory capital or shareholders' equity and their change.

10. 158, 473, 573 are outliers by deferred costs end-period volume and change.
11. 5, 205, 653, and 929 are outliers by resources for deferred expenses and their change.
12. 89, 158, 180, and 573 are outliers for long-term loans and liabilities.
13. 180, 322, 323, 429, and 503 re outliers for short-term loans and liabilities.
14. 231, 431, 802, and 888 are outliers for deferred costs.
15. 322, 503, 929, and 573 are outliers by the volume of production.
16. 146, 506, and 1035 are outliers by production expenses.
17. 110, 172, 231, 688, and 866 are outliers by amount of taxes and other collections.
18. 322 needs a dummy as it has 3940 employees in 2004 (up from 84 in 2002 and 54 in 2003). It also had 316 free-lance employees in 2004 (up from 16 and 12 in 2002 and 2003). 322 reported 6.13 million person-hours in 2004, wage fund of 26.3 million and 1.2 million to free-lances. Other big companies (more than 1000 employees) are 180, 231, 888, 929, and 973. company 36 had 8 unpaid employees in 2004.
19. 172, 929, 950, and 973 employed in different years more than 200 part-time employees.
20. 120, 322, 523, 607, 786, and 848 paid in different years more than 20 thousand to combining workers.
21. 158 is the major outlier by investment in fixed assets. 123 is the outlier by investments into non-material fixed assets (2.8 million in 2003).

To conclude, some dummies are required and some are desirable as able to influence the estimation results individually.

Table 5. Dummies for outliers required

Strongly recommended dummies	322, 573, 929
Advisable dummies	5, 36, 89, 110, 120, 123, 146, 158, 172, 180, 205, 229, 231, 251, 323, 429, 473, 506, 523, 557, 607, 653, 786, 848, 888, 950, 973, 1035

A5. Programming short run model

System 2003

```
global t b tr br W Wbar p Teta Wtotal Wrold w_old;
```

```
Wbar=420.09; p=0.126; Teta=0.5; Wrold=[]; w_old=[]; Wtotal=[];
```

```
RULE=[18, 0.368, 0; 77.38, 0.55455, -2.64273; 130.45, 0.64819, -9.80675; 145.35, 0.66829,-9.92634;...
```

```
799.85, 0.77662, -25.67221; 1255.45, 1.04179, -237.76657; 1802.65, 1.4, -687.48; 100000, 0.75439, 476.33614];
```

```

for i=1:2501
    W=(i-1);
    n=1; %number of iterations for Wr, index of the current W in the RULE system
    while W>=RULE(n,1), n=n+1; end
    t=RULE(n,2); b=RULE(n,3);
    for j=1:n %index of the current iteration for Wr
        tr=RULE(j,2); br=RULE(j,3);
        if n==1, MO=fminbnd(@objective,0,W);
        elseif j==1, MO=fminbnd(@objective,0,RULE(j,1,1));
        elseif j==n, MO=fminbnd(@objective,RULE(j-1,1,1),W);
        else MO=fminbnd(@objective,RULE(j-1,1,1),RULE(j,1,1)); end
        A(j, :) = [MO, objective(MO)]; %matrix of minimums of objective
    end
    [Z,z] = min(A(:,2)); % z is the index of the minimum value of the objective in A
    Wtotal(i)=W; Wrold(i)=A(z,1);
end
w_old=Wrold./Wtotal;
figure; plot(Wtotal, w_old); xlabel('net wage, UAH')
ylabel('reported wage share'); title('Share of the Reported Wage','FontSize',12)
legend('2003'); set(gca,'XTick',0:125:W); grid on

```

System 2004

```

global t b tr br W Wbar p Teta Wtotal Wrnew w_new;
Wbar=559.79; p=0.133; Teta=0.5; Wrnew=[]; w_new=[]; Wtotal=[];
RULE=[154.185, 0.60450, -14.83043; 317.266, 0.62105, -14.98332;...
    437.4135, 0.62944, -15.06095; 2233.2, 0.62944, 0; 100000, 0.19111, 978.88];
for i=1:2501
    W=(i-1); B=[];
    n=1; %number of iterations for Wr, index of the current W in the RULE system
    while W>RULE(n,1), n=n+1; end
    t=RULE(n,2); b=RULE(n,3);

```

```

for j=1:n %index of the current iteration for Wr
    tr=RULE(j,2); br=RULE(j,3);
    if n==1, MO=fminbnd(@objective,0,W);
    elseif j==1, MO=fminbnd(@objective,0,RULE(j,1));
    elseif j==n, MO=fminbnd(@objective,RULE(j-1,1),W);
    else MO=fminbnd(@objective,RULE(j-1,1),RULE(j,1)); end
    B(j, :) = [MO, objective(MO)];
end
[Z,z] = min(B(:,2)); Wtotal(i)=W; Wrnew(i)=B(z,1);
end
w_new=Wrnew./Wtotal;
figure; plot(Wtotal, w_new); xlabel('net wage, UAH');
ylabel('reported wage share'); title('Share of the Reported Wage','FontSize',12)
legend('2004'); set(gca,'XTick',0:125:W); grid on

```

Objective Function

```

function [out1] = objective(Wr)
global t b tr br W Wbar p Teta Wtotal Wrold w_old Wrnew w_new;
if nargin==0, Wr = 0:1:2500; end
k=1+sign(Wbar-Wr);
if W==0
    out1=tr*Wr+br+(Teta+p)*(t*W+b-tr*Wr-br);
else
    out1=(tr*Wr+br)+(1-(1-(1-Wr/W)^2)^0.5)*0.5*(1+(1-(Wr/Wbar)^k)^0.5)*...
        (Teta+p+Teta*p)*(t*W+b-tr*Wr-br);
end

```

A6. Programming long run model

```

k=[]; Tau=[]; Theta=[]; p=[]; c=[]; y=[]; wr=[]; Phi=[];
Z=[]; A=[]; Xi=[]; Res=[]; VarUps=[];
global Theta t Alpha Gama Z Xi VarUps M p;

```

% calibration

```
lv(1)=1.22;
A0=0.304; a=1.000; A(1)=A0*a;
Tau0=0.71; Theta0=0.633;
VarUps0=0.56; VarUps(1)=0.81*0.95;
Beta=0.935; Gama=0.46; Delta=0.085;
Alpha=0.22; Xi=1.52;
for t=1:20
```

% intermediary coefficients

```
A(t+1)=A(t)*a;
VarUps(t+1)=VarUps(t)*0.95;
lv(t+1)=1/(6.88+t)+1.05;
Phi(t+1)=(Beta*A(t)*Gama/(lv(t+1)-...
    Beta*(1-Delta)))^(1/(1-Gama));
Z(t)=Alpha/(1-Gama)*(lv(t+1))^(1-Gama)/Alpha...
    *(Beta*A(t)*(Phi(t+1))^Gama-Phi(t+1)*lv(t+1)...
    +Beta*(1-Delta)*Phi(t+1));
Tau(t)=fzero(@olr1,1);
Theta(t)=M*Xi/(M*exp(0.5*VarUps(t))-Xi)-Tau(t);
```

% streams of state and control variables

```
p(t+1)=(Tau(t)-Tau(t)/(Tau(t)+Theta(t)))/lv(t+1);
c(t)=Tau(t)/(Tau(t)+Theta(t));
k(t+1)=Phi(t+1)*(p(t+1))^(Alpha/(1-Gama));
y(t+1)=A(t+1)*(p(t+1))^Alpha*(k(t+1))^Gama;
wr(t)=1-Xi/(Tau(t)+Theta(t))/exp(0.5*VarUps(t));
end
```

Objective Function

```
function y = olr1(tau)
global Theta t Alpha Gama Z Xi VarUps M;
e=exp(0.5*VarUps(t));
```

$$p = (\alpha + \gamma - 1) / (1 - \gamma);$$

$$y = -1 + Z(t) * (\tau - 1 + \tau * e / X_i - \tau / M)^p \dots$$

$$(1 - (M * X_i - \tau * M * e + \tau * X_i) * (M * e - X_i) / M^2 / X_i^2) + \dots$$

$$(M * X_i - \tau * M * e + \tau * X_i) * (M * e - X_i) / M^2 / X_i$$

A7. Testing hypothesis 1

Dependent Variable: *D_WAGE_AV*.

Method: Least Squares.

Date: 01/15/06, Time: 18:24.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	1.395936	0.194569	7.174503	0.0000
<i>D_REV_NET</i>	0.349087	0.114776	3.041437	0.0024
<i>D_PIT</i>	-0.036180	0.021285	-1.699788	0.1045
<i>FDI_YES2</i>	0.139140	0.292740	0.475302	0.6347
<i>D_TAX_COL</i>	0.001218	0.001337	0.910805	0.3626
R-squared	0.226356	Mean dependent var	0.591442	
Adjusted R-squared	0.223097	S.D. dependent var	2.824966	
S.E. of regression	2.792152	Akaike info criterion	4.895660	
Sum squared resid	9316.353	Schwarz criterion	4.916869	
Log likelihood	-2932.396	F-statistic	18.08691	
Durbin-Watson stat	2.091257	Prob (F-statistic)	0.000002	

Dependent Variable: *D_WAG_FND*.

Method: Least Squares.

Date: 01/15/06, Time: 17:25.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	-9.600259	26.03821	-0.368699	0.7124
<i>D_PIT</i>	-0.004829	0.006786	-0.711583	0.4769
<i>D_REV_NET</i>	0.003510	0.001645	2.133787	0.0331
<i>D_EXP_DIF</i>	0.261029	0.004834	53.99609	0.0000
<i>D_TAX_COL</i>	-0.699155	0.187362	-3.731577	0.0002
<i>FDI_YES2</i>	-8.268711	39.16836	-0.211107	0.8328

R-squared	0.755862	Mean dependent var	41.70783
Adjusted R-squared	0.754839	S.D. dependent var	754.3870
S.E. of regression	373.5250	Akaike info criterion	14.68883
Sum squared resid	1.67E+08	Schwarz criterion	14.71428
Log likelihood	−8807.301	F-statistic	739.3339
Durbin–Watson stat	2.026193	Prob (F-statistic)	0.000000

Dependent Variable: *D_WAGE_RATIO*.

Method: Least Squares.

Date: 01/15/06, Time: 17:34.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	−0.203455	0.252306	−0.806384	0.4202
<i>D_PIT</i>	−1.531167	1.502241	−1.019255	0.3083
<i>D_REV_NET</i>	6.56E−06	1.48E−05	0.443406	0.6576
<i>FDI_YES2</i>	−0.154479	0.379531	−0.407025	0.6841
R-squared	0.001135	Mean dependent var	0.018276	
Adjusted R-squared	−0.001371	S.D. dependent var	3.618346	
S.E. of regression	3.620826	Akaike info criterion	5.414609	
Sum squared resid	15680.01	Schwarz criterion	5.431576	
Log likelihood	−3244.765	F-statistic	0.452854	
Durbin–Watson stat	1.966587	Prob (F-statistic)	0.715324	

Dependent Variable: *D_WAGE_AV*.

Method: Least Squares.

Date: 01/15/06, Time: 17:51.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	1.404522	0.195132	7.197823	0.0000
<i>D_REV_NET</i>	3.56E−05	1.15E−05	3.098275	0.0020
<i>D_PIT</i>	−0.025592	0.01263	−2.025811	0.0983
<i>D_PIT×IND_AG</i>	0.774758	1.960142	0.395256	0.6927
<i>D_PIT×IND_IND</i>	−0.550211	1.642412	−0.335002	0.7377
<i>D_PIT×IND_TRD</i>	−2.047398	1.331312	−1.537880	0.1243
<i>D_PIT×IND_SRV</i>	−3.883412	1.655551	−2.345691	0.0192
<i>D_PIT×IND_EST</i>	−1.642274	1.655837	−0.991809	0.3215
<i>FDI_YES2</i>	0.203242	0.303291	0.670121	0.5029
<i>D_TAX_COL</i>	0.001241	0.001339	0.926841	0.3542

R-squared	0.132930	Mean dependent var	0.591442
Adjusted R-squared	0.125616	S.D. dependent var	2.824966
S.E. of regression	2.788549	Akaike info criterion	4.897218
Sum squared resid	9253.444	Schwarz criterion	4.939635
Log likelihood	−2928.331	F-statistic	4.502384
Durbin–Watson stat	2.095944	Prob (F-statistic)	0.000008

Dependent Variable: *D_WAGE_AV*.

Method: Least Squares.

Date: 01/15/06, Time: 17:52.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	1.423420	0.194791	7.307410	0.0000
<i>D_REV_NET</i>	3.48E−05	1.15E−05	3.036551	0.0024
<i>D_PIT</i>	−0.190867	0.093734	−2.036205	0.1021
<i>D_PIT×OWN_PRV</i>	−0.182268	0.227489	−2.999122	0.0028
<i>D_PIT×OWN_STA</i>	1.602640	1.841505	0.870288	0.3843
<i>D_PIT×OWN_COL</i>	−0.219293	1.373640	1.615630	0.1064
<i>FDI_YES2</i>	0.138122	0.304603	0.453450	0.6503
<i>D_TAX_COL</i>	0.001108	0.001339	0.827341	0.4082
R-squared	0.133959	Mean dependent var	0.591442	
Adjusted R-squared	0.128285	S.D. dependent var	2.824966	
S.E. of regression	2.784727	Akaike info criterion	4.892821	
Sum squared resid	9243.605	Schwarz criterion	4.926755	
Log likelihood	−2927.692	F-statistic	5.985927	
Durbin–Watson stat	2.105863	Prob (F-statistic)	0.000001	

Dependent Variable: *D_WAGE_AV*.

Method: Least Squares.

Date: 01/29/06, Time: 17:54.

Sample: 1 1200

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	1.401216	0.194673	7.197785	0.0000
<i>D_REV_NET</i>	3.54E−05	1.15E−05	3.083069	0.0021
<i>D_PIT</i>	−0.617302	0.384409	−1.605843	0.1019
<i>D_PIT×REG_CT</i>	1.523773	1.538502	0.990426	0.3222

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>D_PIT×REG_ES</i>	0.349676	1.384927	0.252487	0.8007
<i>D_PIT×REG_ST</i>	−0.623852	1.612120	−0.386976	0.6988
<i>D_PIT×REG_W</i>	3.765205	1.732014	2.173888	0.0299
<i>FDI_YES2</i>	0.212716	0.294911	0.721289	0.4709
<i>D_TAX_COL</i>	0.001240	0.001335	0.928320	0.3534
R-squared	0.132493	Mean dependent var	0.591442	
Adjusted R-squared	0.125994	S.D. dependent var	2.824966	
S.E. of regression	2.788008	Akaike info criterion	4.896004	
Sum squared resid	9257.633	Schwarz criterion	4.934179	
Log likelihood	−2928.602	F-statistic	4.999781	
Durbin–Watson stat	2.097347	Prob (F-statistic)	0.000004	

Dependent Variable: *D_WAGE_AV*.

Method: Least Squares.

Date: 01/29/06, Time: 18:10.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	1.413747	0.194607	7.264617	0.0000
<i>D_REV_NET</i>	3.43E−05	1.15E−05	2.988258	0.0029
<i>D_PIT</i>	−0.020282	0.010645	−1.905124	0.1099
<i>D_PIT×SIZ_BIG2</i>	−2.552500	1.375474	−1.855724	0.0637
<i>FDI_YES2</i>	0.183398	0.293412	0.625053	0.5321
<i>D_TAX_COL</i>	0.001003	0.001341	0.747967	0.4546
R-squared	0.129156	Mean dependent var	0.591442	
Adjusted R-squared	0.125090	S.D. dependent var	2.824966	
S.E. of regression	2.789301	Akaike info criterion	4.894447	
Sum squared resid	9289.560	Schwarz criterion	4.919897	
Log likelihood	−2930.668	F-statistic	7.171502	
Durbin–Watson stat	2.086509	Prob (F-statistic)	0.000001	

A8. Testing hypothesis 2Dependent Variable: *D_PIT_COL*.

Method: Least Squares.

Date: 01/18/06, Time: 18:44.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	24.61318	8.802741	2.796082	0.0053
<i>D_PIT</i>	2.6543	0.444375	5.973140	0.0000
<i>D_WAG_FND_COR</i>	0.130936	0.005084	25.75482	0.0000
R-squared	0.364085	Mean dependent var	-18.12327	
Adjusted R-squared	0.363022	S.D. dependent var	158.4493	
S.E. of regression	126.4598	Akaike info criterion	12.52022	
Sum squared resid	19142511	Schwarz criterion	12.53295	
Log likelihood	-7509.133	F-statistic	342.6633	
Durbin-Watson stat	2.006215	Prob (F-statistic)	0.000000	

Dependent Variable: *D_PIT_COL*.

Method: Least Squares.

Date: 01/18/06, Time: 18:30.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	23.69040	8.647655	2.739517	0.0062
<i>D_PIT</i>	4.015340	0.723680	5.548505	0.0000
<i>D_PIT</i> × <i>IND_AG</i>	-3.720214	10.51590	-0.353773	0.7236
<i>D_PIT</i> × <i>IND_IND</i>	2.830401	0.648802	4.362569	0.0000
<i>D_PIT</i> × <i>IND_TRD</i>	-1.931293	0.602473	-3.205603	0.0014
<i>D_PIT</i> × <i>IND_SRV</i>	-1.548585	0.668614	-2.316109	0.0207
<i>D_PIT</i> × <i>IND_EST</i>	-8.825655	1.067109	-1.209186	0.2268
<i>D_WAG_FND_COR</i>	0.131343	0.005003	26.25267	0.0000
R-squared	0.393798	Mean dependent var	-18.12327	
Adjusted R-squared	0.390238	S.D. dependent var	158.4493	
S.E. of regression	123.7287	Akaike info criterion	12.48070	
Sum squared resid	18248068	Schwarz criterion	12.51464	
Log likelihood	-7480.422	F-statistic	110.6203	
Durbin-Watson stat	2.028232	Prob (F-statistic)	0.000000	

Dependent Variable: *D_PIT_COL*.

Method: Least Squares.

Date: 01/18/06, Time: 18:34.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	18.15946	7.999902	2.269960	0.0234
<i>D_PIT</i>	5.126114	1.658742	3.090360	0.0020
<i>D_PIT</i> × <i>SIZ_BIG2</i>	9.555679	0.596081	16.03083	0.0000
<i>D_WAG_FND_COR</i>	0.142719	0.004673	30.54392	0.0000
R-squared	0.476558	Mean dependent var		−18.12327
Adjusted R-squared	0.475245	S.D. dependent var		158.4493
S.E. of regression	114.7806	Akaike info criterion		12.32725
Sum squared resid	15756807	Schwarz criterion		12.34422
Log likelihood	−7392.350	F-statistic		362.9588
Durbin–Watson stat	2.070715	Prob (F-statistic)		0.000000

Dependent Variable: *D_PIT_COL*.

Method: Least Squares.

Date: 01/18/06, Time: 18:35.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	16.07398	8.292619	1.938348	0.0528
<i>D_PIT</i>	6.521124	2.215212	2.943791	0.0033
<i>D_PIT</i> × <i>OWN_PRV</i>	−69.96490	66.53268	−1.051587	0.2932
<i>D_PIT</i> × <i>OWN_STA</i>	1.277873	0.012426	10.28337	0.0000
<i>D_PIT</i> × <i>OWN_COL</i>	−8.675945	57.16796	−0.151762	0.8794
<i>D_WAG_FND_COR</i>	0.140325	0.004828	29.06695	0.0000
R-squared	0.441188	Mean dependent var		−18.12327
Adjusted R-squared	0.438847	S.D. dependent var		158.4493
S.E. of regression	118.6945	Akaike info criterion		12.39597
Sum squared resid	16821544	Schwarz criterion		12.42142
Log likelihood	−7431.583	F-statistic		188.5348
Durbin–Watson stat	2.047428	Prob (F-statistic)		0.000000

Dependent Variable: *D_PIT_COL*.

Method: Least Squares.

Date: 01/18/06, Time: 21:10.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	24.53673	8.823746	2.780762	0.0055
<i>D_PIT</i>	7.448580	1.686316	4.417076	0.0000
<i>D_PIT</i> × <i>REG_CT</i>	83.72973	69.84753	1.198750	0.2309
<i>D_PIT</i> × <i>REG_ES</i>	2.256270	62.86475	0.035891	0.9714
<i>D_PIT</i> × <i>REG_ST</i>	−16.95431	73.05485	−0.232076	0.8165
<i>D_PIT</i> × <i>REG_W</i>	3.669871	78.64327	0.046665	0.9628
<i>D_WAG_FND_COR</i>	0.130841	0.005109	25.60999	0.0000
R-squared	0.365445	Mean dependent var	−18.12327	
Adjusted R-squared	0.362254	S.D. dependent var	158.4493	
S.E. of regression	126.5360	Akaike info criterion	12.52475	
Sum squared resid	19101559	Schwarz criterion	12.55444	
Log likelihood	−7507.848	F-statistic	114.5098	
Durbin–Watson stat	2.003696	Prob (F-statistic)	0.000000	

A9. Testing hypothesis 3

Dependent Variable: *D_NET_WAGE_AV*.

Method: Least Squares.

Date: 01/24/06, Time: 22:26.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	−0.649649	0.050470	−12.87193	0.0000
<i>D_PIT</i>	−9.034262	4.422167	−2.042949	0.0935
<i>D_WAGE_AV</i>	0.731657	0.007319	99.96718	0.0000
<i>FDI_YES2</i>	0.066822	0.074351	0.898731	0.3690
<i>D_TAX_COL</i>	−0.000361	0.000338	−1.070192	0.2847
R-squared	0.896174	Mean dependent var	1.171969	
Adjusted R-squared	0.895826	S.D. dependent var	2.197192	
S.E. of regression	0.709165	Akaike info criterion	2.154702	
Sum squared resid	600.9839	Schwarz criterion	2.175910	
Log likelihood	−1287.821	F-statistic	2578.651	
Durbin–Watson stat	1.973510	Prob (F-statistic)	0.000000	

Dependent Variable: *D_NET_WAGE_AV*.

Method: Least Squares.

Date: 01/24/06, Time: 15:28.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	−0.640456	0.050381	−12.71219	0.0000
<i>D_PIT</i>	−8.824470	4.376088	−2.016529	0.0851
<i>D_PIT</i> × <i>SIZ_BIG2</i>	−1.072960	0.348870	−3.075526	0.0021
<i>D_WAGE_AV</i>	0.730399	0.007305	99.99078	0.0000
<i>FDI_YES2</i>	0.085513	0.074338	1.150328	0.2502
<i>D_TAX_COL</i>	−0.000453	0.000338	−1.341147	0.1801
R-squared	0.896990	Mean dependent var	1.171969	
Adjusted R-squared	0.896558	S.D. dependent var	2.197192	
S.E. of regression	0.706669	Akaike info criterion	2.148478	
Sum squared resid	596.2604	Schwarz criterion	2.173928	
Log likelihood	−1283.087	F-statistic	2079.415	
Durbin–Watson stat	1.981749	Prob (F-statistic)	0.000000	

Dependent Variable: *D_NET_WAGE_AV*.

Method: Least Squares.

Date: 01/24/06, Time: 22:30.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	−0.629653	0.050128	−12.56085	0.0000
<i>D_PIT</i>	−9.513967	4.635529	−2.051918	0.0842
<i>D_PIT</i> × <i>IND_AG</i>	1.879908	0.492966	3.813460	0.0001
<i>D_PIT</i> × <i>IND_IND</i>	0.608641	0.413022	1.473628	0.1408
<i>D_PIT</i> × <i>IND_TRD</i>	0.957737	0.334597	2.862356	0.0043
<i>D_PIT</i> × <i>IND_SRV</i>	1.202352	0.417269	2.881475	0.0040
<i>D_PIT</i> × <i>IND_EST</i>	−0.532873	0.416472	−1.279494	0.2010
<i>D_WAGE_AV</i>	0.732232	0.007261	100.8475	0.0000
<i>FDI_YES2</i>	0.072099	0.076267	0.945350	0.3447
<i>D_TAX_COL</i>	−0.000414	0.000335	−1.234034	0.2174
R-squared	0.898900	Mean dependent var	1.171969	
Adjusted R-squared	0.898135	S.D. dependent var	2.197192	
S.E. of regression	0.701261	Akaike info criterion	2.136425	
Sum squared resid	585.2023	Schwarz criterion	2.178842	
Log likelihood	−1271.855	F-statistic	1175.615	
Durbin–Watson stat	1.969337	Prob (F-statistic)	0.000000	

Dependent Variable: *D_NET_WAGE_AV*.

Method: Least Squares.

Date: 01/29/06, Time: 22:31.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	−0.628310	0.049930	−12.58373	0.0000
<i>D_PIT</i>	−8.201779	4.354562	−1.883489	0.0612
<i>D_PIT</i> × <i>OWN_PRV</i>	−0.564409	0.392971	−1.436260	0.1512
<i>D_PIT</i> × <i>OWN_STA</i>	−2.774992	0.461749	−6.009746	0.0000
<i>D_PIT</i> × <i>OWN_COL</i>	−0.533660	0.344788	−1.547791	0.1219
<i>D_WAGE_AV</i>	0.731697	0.007236	101.1258	0.0000
<i>FDI_YES2</i>	0.096381	0.076367	1.262078	0.2072
<i>D_TAX_COL</i>	−0.000542	0.000334	−1.621941	0.1051
R-squared	0.899574	Mean dependent var		1.171969
Adjusted R-squared	0.898984	S.D. dependent var		2.197192
S.E. of regression	0.698334	Akaike info criterion		2.126407
Sum squared resid	581.3036	Schwarz criterion		2.160341
Log likelihood	−1267.844	F-statistic		1525.342
Durbin–Watson stat	1.987596	Prob (F-statistic)		0.000000

Dependent Variable: *D_NET_WAGE_AV*.

Method: Least Squares.

Date: 01/29/06, Time: 22:32.

Sample: 1 1200.

Included observations: 1200.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>C</i>	−0.635032	0.049719	−12.77236	0.0000
<i>D_PIT</i>	−7.47750	3.721193	−2.009436	0.0536
<i>D_PIT</i> × <i>REG_CT</i>	1.741679	13.41583	0.129822	0.8561
<i>D_PIT</i> × <i>REG_ES</i>	2.313040	3.364911	0.687408	0.3325
<i>D_PIT</i> × <i>REG_ST</i>	1.531874	1.909583	0.802203	0.1258
<i>D_PIT</i> × <i>REG_W</i>	1.340557	14.59220	0.091868	0.9581
<i>D_WAGE_AV</i>	0.731548	0.007216	101.3771	0.0000
<i>FDI_YES2</i>	0.029558	0.073742	0.400830	0.6886
<i>D_TAX_COL</i>	−0.000387	0.000332	−1.165071	0.2442
R-squared	0.900020	Mean dependent var		1.171969
Adjusted R-squared	0.899348	S.D. dependent var		2.197192
S.E. of regression	0.697074	Akaike info criterion		2.123622
Sum squared resid	578.7220	Schwarz criterion		2.161798
Log likelihood	−1265.173	F-statistic		1340.168
Durbin–Watson stat	2.000495	Prob (F-statistic)		0.000000

REFERENCES

- Albu, Lucian-Liviu (2004) Estimating the Size of Underground Economy in Romania, *The Economics of Transition* (submitted for publishing).
- Allingham, Michael G. and Agnar Sandmo (1972) Income Tax Evasion: A Theoretical Analysis, *Journal of Public Economics* **1** (3–4), 323–338.
- Amaral, Pedro S. and Erwan Quintin (2003) *The Implications of Capital-Skill Complementarity in Economies with Large Informal Sectors*, <http://ideas.repec.org/p/wpa/wuwpma/0309017.html>.
- Avitabile, Ciro (2003), *PAYG parametric reforms and labor in the informal sector*, mimeo.
- Beloded, O. (2005) Shadow Economy of Ukraine: the Case of Financial Constraints, *Economics Education and Research Consortium* (Kyiv: A thesis submitted in partial fulfilment of the requirements for the degree of Master of Arts in Economics).
- Boeri T. and P. Garibaldi (2001) Shadow Activity and Unemployment in a Depressed Labor Market, *IGIER Working Paper* No. 77 (Italy, Milano: Bocconi University).
- Bouev, M. (2002) *Official Regulations and the Shadow Economy: A Labour Market Approach* (Oxford: St. Antony's College).
- Clotfelter, Charles T. (1983) Tax Evasion and Tax Rates: an Analysis of Individual Returns, *The Review of Economics and Statistics* **65** (3), 363–373.
- Cowell, Frank A. (2002) Sticks and Carrots. *Paper prepared for the Conference on the Crisis in Tax Administration, The Brookings Institute*, (Washington DC).
- Cowell, Frank A. (1985) Tax evasion with Labour Income, *Journal of Public Economics* **26**, 19–34.
- Creedy, John (1998). *Measuring Welfare Changes and Tax Burdens* (Edward Elgar Publishing, 221 p).
- Feinstein, Johnathan S. (1991) Econometric Analysis of Income Tax Evasion and Its Detection, *RAND Journal of Economics* **22** (1), 14–35.
- Galbiati, Roberto and Alberto Zanardi (2001), The Redistributive Effects of Tax Evasion: a Comparison between Conventional and Multi-Criteria Perspectives, *Working Paper* No. 81 (Università Commerciale Luigi Bocconi Econpublica Working Paper Series).
- Graversen, Ebbe Krogh and Nina Smith (2001) Tax Evasion and Work in the Underground Sector, *Working Paper* 01-02 (Centre for Labour Market and Social Research).
- ICPS Analytical Report (2004) *De-shadowing of personal incomes of citizens* (Kyiv).
- Johnson, S., D. Kaufmann, and A. Shleifer (1997) The Unofficial Economy in Transition, *Brookings Papers on Economic Activity* **2** (Fall), 159–239.
- Kalugin V. (2003). The authorities look in the shadow, *Business* №25 (544), (Kyiv).
- Kaufmann, D. (1997). *The missing pillar of a growth strategy for Ukraine: reforms for private sector development*, in: P.K. Cornelius and P. Lenain (eds.), *Ukraine: Accelerating the Transition to Market*, International Monetary Fund (Washington).
- Kesselman, Jonathan R. (1989) Income tax evasion: an Intersectoral Analysis, *Journal of Public Economics* **38**, 137–182.

- Khmilevska, Nataliya (2001) Modelling of Household Behaviour in Terms of Shadow Economy: Labour Supply, *Economics Education and Research Consortium* (Kyiv: A thesis submitted in partial fulfilment of the requirements for the degree of Master of Arts in Economics).
- Lemieux, Thomas⁶, Bernard Fortin, and Pierre Frechette (2004) The Effects of Taxes on Labour Supply in the Underground⁶ *The American Economic Review* **84** (1), 231–254.
- Loayza, Norman A. (1997). Economics of the Informal Sector: A Simple Model and Some Empirical Evidence from Latin America, *The World Bank Policy Research Working Paper* 1727.
- Salanie, Bernard (2003) *The Economics of Taxation* (The MIT Press, 236 p).
- Schneider, Friedrich and Christina Burger (2004). Formal and Informal Labour Markets: Challenges and Policy in the Central and Eastern European new EU Members and Candidate Countries, *Johannes Kepler University of Linz Working Paper* No. 0405.
- Sinelnikov S., S. Batkibetov, P. Kadochnikov, and D. Nekipelov (2003) Evaluation of the income tax reform in the Russian Federation, *Voprosy Ekonomiki*, No. 6..
- Slemrod, Joel (1998) A general model of the behavioral response to taxation, *NBER Working Paper* 6582.
- Slemrod, Joel and Shlomo Yitzhaki (2000), Tax Avoidance, Evasion, and Administration. *NBER Working Paper* 7473.
- Stepanyan, V. (2003) Reforming Tax Systems: Experience of the Baltics, Russia, and Other Countries of the Former Soviet Union, *IMF Working Paper* WP/03/173.
- UUIE Analytical Report (2003) *Taxes in Ukraine: from punitive to stimulating function* (Kyiv).
- Vasilyeva A., E. Gurvich, and V. Subottin (2003). Economic analysis of the tax reform, *Voprosi Ekonomiki* №6 (Moscow).
- Watson, Harry (1985) Tax Evasion and Labour Markets, *Journal of Public Economics* **27**, 231–246.
- Wooldridge, Jeffrey M. (2001) *Econometric Analysis of Cross Section and Panel Data* (The MIT Press; 1st edition, 740 p.).
- Wooldridge, Jeffrey M. (2003) *Solutions Manual and Supplementary Materials for Econometric Analysis of Cross Section and Panel Data* (The MIT Press, 250 p.).
- Yaniv G. (1999) Tax Compliance and Advance Tax Payments: a Prospect Theory Analysis, *National Tax Journal* **52** (4), 753–764.